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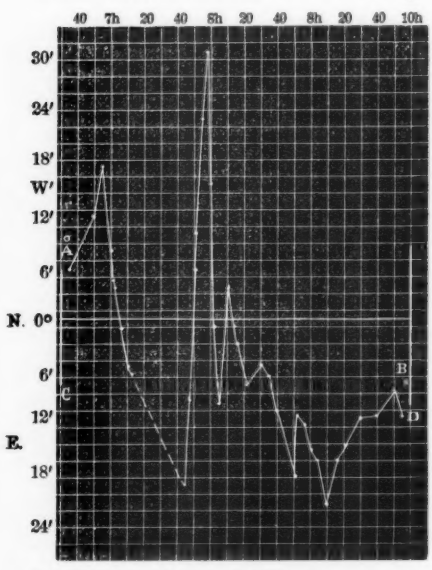
ART. XII.—*Observations on the Variation of the Magnetic Declination in connection with the Aurora of October* 14, 1870. *With remarks on the physical connection between changes in area of disturbed solar surface and magnetic perturbations;* by ALFRED M. MAYER, Ph.D.

THE aurora of October 14th was first observed by me at 6^h 30^m P. M. as a ruddy glow in the N.N.E., reaching to about 40° above the horizon. The magnetic observations were commenced at 6^h 35^m. In the following table the first column contains the times of observation in Bethlehem mean time (long. E. Washington 6^m 42^s, lat. N. 40° 36′ 24″), while in the second are given the declinations, + indicating a W. and − an E. movement of the N. end of the magnet in reference to the line of mean declination of the day, taken as the mean of the maximum E. elongation at 8^h 30^m and the maximum W. elongation at 13^h 17^m. This line of mean declination we will call 0°.

Time.	Declination.	Remarks.
6^h 35^m	+ 5′·70	An arch of silvery light in the N., whose sagitta appears to be in the magnetic meridian. Clouds on the horizon partly obscure its outline.
6 50	+11′·46	Arch about 20° in altitude; definition faint. Streamers W.N.W. and E.N.E.
6 56	+18′·37	Aurora the same as at 6 50.
7 00	+ 8′·00	
7 02	+ 4′·55	
7 03	+ 3′·39	
7 6½	− 1′·20	
7 9	− 5′·81	Arch very faint; no streamers.
7 12	− 6′·96 to −5′·81	[altitude.
7 46	−21′·94 to −17′·23	Streamers of crimson hue E.N.E. reaching to 60° in

Time.	Declination.	Remarks.
$7^h\ 48^m$	$-12'{\cdot}72$ to $-6'{\cdot}96$	Crimson and greenish streamers N.W. to N.E.
7 51½	$+\ 4'{\cdot}55$ to $+8'{\cdot}$	
7 52½	$+10'{\cdot}31$ to $11'{\cdot}46$	Greenish streamers extending about 50° above arch.
7 55½	$+21'{\cdot}83$ to $25'{\cdot}28$	Aurora nearly the same as at $7^h\ 52\frac{1}{2}^m$.
7 57½	$+31'{\cdot}04$ to $32'{\cdot}19$	
8 0½	$+22'{\cdot}98$ to $17'{\cdot}22$	This easterly motion of the magnet is steady and rapid. At the same time deep rosy streamers flash up in the N.N.W.
8 1¼	$-\ 1'{\cdot}20$	Red streamers have disappeared.
8 3½	$-\ 8'{\cdot}12$	Aurora the same as at $8 - 1\frac{1}{4}$.
8 5½	$-10'{\cdot}42$	Aurora same as above.
8 10	$+\ 2'{\cdot}24$ to $4'{\cdot}55$	Crimson glow in N.E.
8 16	$-\ 3'{\cdot}51$ to $-2'{\cdot}36$	
8 21½	$-\ 9'{\cdot}27$ to $-6'{\cdot}96$	Aurora has declined to a faint white arch.
8 30	$-\ 5'{\cdot}81$ to $-5'{\cdot}24$	Faint white streamers from the arch.
8 35	$-\ 6'{\cdot}96$	Streamers very faint. Arch ill-defined; moon is rising.
8 40	$-12'{\cdot}72$	
8 50	$-18'{\cdot}48$	
8 51	$-11'{\cdot}57$	Aurora still fainter.
8 55	$-13'{\cdot}30$ to $12'{\cdot}15$	" barely visible.
9 00	$-15'{\cdot}60$	
9 5	$-17'{\cdot}91$	
9 10	$-22'{\cdot}52$	Aurora invisible.
9 16	$-17'{\cdot}33$	" "
9 20	$-15'{\cdot}03$	" "
9 30	$-11'{\cdot}57$	" "
9 40	$-11'{\cdot}57$	" "
9 50	$-\ 8'{\cdot}69$	" "
10 00	$-11'{\cdot}86$	" "

These determinations are here expressed graphically. The



ordinates above the 0° line indicate a W., and those below, an E. position of the N. end of the magnet referred to the line of mean declination of Oct. 14. The vertical line C shows the average daily range ($12'{\cdot}85$) as given by the mean of the range of the five days before and of the five days after the auroral display; not including in the mean the range of Oct. 14. The line D represents the range ($18'{\cdot}43$) of Oct. 14. A is the position the magnet had ($+9'{\cdot}33$) at $1^h\ 17^m$ P. M. on Oct. 14, while B is the declination ($-7'{\cdot}25$) at 8^h (the time of greatest E. elongation) on the morning of Oct. 15.

It will be observed, on referring to the column of "Remarks" in connection with the curve, that the motion of the needle coincided in its maxima and minima with the greatest activity of the aurora; and the rapid and steady easterly motion, from $7^h\ 57^m{\cdot}5$ to $8^h\ 5^m{\cdot}5$, of $42'{\cdot}04$, is remarkable. Viewed in the declinometer it appeared exactly as though a distant disturbing body was gradually receding from the magnet. The flashing up of brilliant streamers at the time of the beginning of this easterly motion is also to be noticed.

The magnet used in these observations is a cylindrical bar 8 ins. long 0·4 in. in diameter, attached to a plane mirror 2 ins. square, and suspended by 2 ft. of untwisted silk fibers. The scale is placed 3 meters from the mirror and with the telescope deflections of 10″ can be read.

It is to be remarked that the auroral observations do not comport in accuracy with the observations of declination. Having no assistance, I could only observe from a N. window directly after having obtained the scale readings, therefore there are many phenomena of this aurora, which appeared in the zenith, and S. of E. and W., which I did not observe.

In connection with the above observation, I will here give an account of a systematic work in which I am engaged and which furnishes a few facts related to the subject of this paper.

Every day about 11^h (if clear; if cloudy at the nearest possible time thereto) the mean penumbral diameter,* in seconds, of every spot and tache on the sun is measured. These diameters are then reduced to what they would be if viewed normally. Each of these measures is then squared and *their sum* gives a number which will vary with the umbral and penumbral areas. These daily numbers are therefore directly comparable quantities of the areas of solar disturbance; at least so far as that disturbance is evinced in the formation of spots. Similar measures are made on all the faculæ I can manage. Remarks are also recorded as to changes in spots and faculæ. In connection with the above measures the daily range of magnetic declination is determined to 10″.

The object of this work is to discover, if possible, a more certainly based physical connection between the daily *changes of area* of solar disturbance and the variation of daily range of declination. It seems that if the ten-year cycle of solar spots has a physical connection with the varying mean yearly range of declination, that such a connection can be detected and satisfactorily established—if not in the special cases of ordinary daily variation of declination—at least in the cases of great magnetic disturbances or "storms" either accompanied or not by auroral displays. But, as a spot indicates—if not entirely, at

* When the greater diameter equals or exceeds twice that of the lesser the spot is divided into two or more measures.

least principally—an effect of an action which has done its work, we must look more minutely to the *changes in area of disturbance*. For, if the connection exist, it will show itself principally *during* the periods of rapid increase or decrease in area of solar disturbance and not when a maximum or minimum area has been reached and remains constant.

These remarks are illustrated by measures on the penumbral areas made before and after the auroral displays of the 14th Oct. and of Oct. 24 and 25.

The declination range on Oct. 11, three days before the aurora, was 11′·23 and increased with the area of solar disturbance to the 14th when it reached 18′·43 and the area-number on this day equalled 17075; but on Oct. 15th, the day *after* the aurora, the declination range had *fallen* to 11′·52 while the area-number had reached 18875, showing an increase of 1800 from noon of the 14th to noon of the 15th, *during which interval* the aurora broke forth. On the 16th the range was 11′·52 and the area-number 15795.

On Oct. 21, three days before the auroral display of Oct. 24, the declination range was only 3′·94; the area-number 13748. On Oct. 22, decl. =12′·75; area-number =14732. On Oct. 23, decl. =11′·53; area-number =15991. On Oct. 24, the aurora (as I subsequently learned from the newspapers) was observed at Cincinnati and Cleveland at 5 A. M. I observed myself the great disturbance a few minutes before 8 A. M., when I began my magnetic observations for obtaining the max. E. elongation. At 11 A. M. the measure of solar disturbance gave 16954 and the observed declination range on that day equalled 44′·79. On Oct. 25, it reached 54′·63.* On Oct. 26, the declination range equalled 14′·26 and the area-number had declined to 11959. Here also we observe that the aurora appeared during the period of increase in the penumbral surface.

These facts, brought forward as illustrations of my remarks and not as *proof* of the physical connection of disturbed solar area and magnetic perturbation,—for that will require almost constant coincidences,—show at once wherein lies the difficulty of such a research; a difficulty which seems not to have been appreciated by those who have given their energies more to a mathematical than to a physical analysis of the connection of these phenomena; and that is, the frequent impossibility of fixing the *time* at which such a change in area took place. It is very evident, in the first example, that it took place between noon of the 14th and noon of the 15th, but whether it coincided with the auroral display and magnetic perturbation could only have been determined by means of solar measurements, or

* On the 24th the disturbance was greatest between 9 and 10 A. M. On Oct. 25, the greatest perturbations were from 12 M. to 2–56 P. M. During the evening displays of this aurora the needle was only slightly deflected. 113 observations were made by me on this aurora.

photographs, taken at several stations differing greatly in longitude. This shows the absolute necessity of several such stations; and that future research in this direction cannot rely alone on the work of the Kew Observatory. Also, the prevalence of cloudy weather in England, especially during the fall and winter months, will add force to the above opinion.

Rapid changes in spot-area are well known to all students of the solar surface. A good example occurred in the largest spot in the S.W. quadrant of the sun during the time of the memorable eclipse of Aug. 7, 1869. Measurements on two photographs, taken at intervals of about two hours gave a closing up of the umbra of 2360 miles in a N.E. and S.W. direction. (See my report on the eclipse in Oct. No. of the Jour. of the Franklin Inst.). The astronomer Wallaston says: —"Once I saw, with a 12-inch reflector, a spot burst in pieces while I was looking at it. I could not expect such an event, and therefore cannot be certain of the exact particulars; but the appearance, as it struck me at the time, was like that of a piece of ice when dashed on a frozen pond, which breaks in pieces, and slides on the surface in various directions. I was then a very young astronomer, but I think I may be sure of the fact."

Carrington, Hodgson and Brodie have observed brilliant clouds appear in the neighborhood of spots, and progress with a velocity of over 6,000 miles per minute; while Prof. C. A. Young has recently made a most remarkable spectroscopic observation of two such brilliant clouds—together over 130,000 miles in breadth—which in ten minutes had contracted their dimensions to an enormous extent; this however, judging from analogy, was probably due to vertical motion.

The question now naturally presents itself:—In case this physical connection between the disturbed solar area and the terrestrial magnetic condition exist, in what does it consist? What is the nature of this connection? Is it owing to an inductive action of the sun? if so, the magnetic intensity of a body depending greatly upon the condition of its surface, that inductive action will vary with the character of its surface. If this be the case then we should take into consideration the probable condition of the hidden solar hemisphere, deduced from preceding observations on it where it was visible combined with subsequent ones when it again appeared. But can we apply such reasoning to a body covered with tumultuous gases heated to an enormous temperature? Does not the connection consist in the action of the solar vibrations sent forth from the chief source of all energy? The experiments of Morrichini, Mrs. Somerville, Zantedeschi and others were once viewed as conclusively showing effects produced by these vibrations sufficient, not only to increase the magnetic intensity of natural and arti-

ficial magnets, but also to give magnetism to steel needles previously devoid of that property; but the more recent experiments of Riess and Moser* cast such doubt over preceding results that the subject has since received but little attention. It is also to be remarked that Faraday, when in Rome with Sir H. Davy in May, 1814, spent several hours at the house of Morrichini, working with his apparatus and under his directions, but could not succeed in magnetizing a needle. Morrichini attributed the failure to the misty state of the atmosphere.

With our present imperfect knowledge of the various forms of energy existing in the solar emanation these questions cannot be answered; but the fact that they can be asked, and the fundamental cosmical relations which will be revealed by their solution, is sufficient to induce men of sicence again to attack this problem,—though its solution baffled all the manipulative ingenuity and philosophical acumen of a Faraday†—the correlation of the solar emanations and electricity and magnetism.

Art. XIII.—*Notes on Granitic Rocks;* by T. Sterry Hunt, LL.D., F.R.S. First Part.‡

(Read before the American Association for the Advancement of Science at Troy, August 20, 1870.)

Contents of Sections.—§ 1–2, Definitions of granite and syenite; § 3, Structure of granitic and gneissic rocks; § 4–5, Felsites and felsite-porphyries; § 6, Gneisses and granites of New England; § 7, Granitic dykes and granitic veinstones; § 8, Scheerer's theory of granitic veins; § 9–10, Elie de Beaumont on granites and granitic emanations; § 11, Granitic distinguished from concretionary veins; § 12, Von Cotta on granitic veins; § 13–14, The author's views on the concretionary origin of granitic veins; § 15, The banded structure of granitic veins.

§ 1. The name of granite is employed to designate a supposed eruptive or exotic unstratified composite rock, granular, crystalline in texture, and consisting essentially of orthoclase-feldspar and quartz, with an admixture of mica, and frequently of a triclinic feldspar, either oligoclase or albite. This is the definition of granite given by most writers on lithology, and applies to a great portion of what are commonly called granitic rocks; there are, however, crystalline granite-like aggregates in which the mica is replaced by a dark colored hornblende or amphibole, and to such a compound rock many authors have given the name of syenite, while to those in which mica and hornblende co-exist, the name of syenitic granite is applied. It is observed

* Ann. de Chem. et de Phys., t. xlii, p. 304.

† See Life and Letters of Faraday, vol. ii, pp. 301 *et seq.* and p. 351.

‡ This, with the following part, embraces the matter of the paper read at Troy in August last. It is proposed in the third and fourth parts to describe the Laurentian veins and to consider the subject of eruptive granites.

that in certain of these hornblendic granites, the quartz becomes less in amount than in ordinary granites, and finally disappears altogether, giving rise to a rock composed of orthoclase and hornblende only. To this binary aggregate von Cotta and Zirkel would restrict the term syenite, which was already defined by d'Omalius d'Halloy to be a crystalline aggregate of hornblende and feldspar, by which orthoclase-feldspar may be understood, since he describes varieties of syenite as passing into diorite, a name by most modern lithologists restricted to a compound of albite or some more basic triclinic feldspar with hornblende. It is apparently by failing to appreciate the distinction between orthoclase and triclinic feldspar in this connection, that Haughton has lately described under the name of syenite rocks composed of crystalline labradorite and hornblende.

§ 2. Naumann, regarding orthoclase and quartz as the essential constituents of granite, designates those aggregates which contain mica as mica-granites, and thus distinguishes them from hornblende-granites, in which the mica is replaced by hornblende. These definitions seem the more desirable as the name of granite is popularly applied both to the hornblendic and the micaceous aggregates of orthoclase and quartz. There are not wanting examples of well-defined rocks of this kind in which both mica and hornblende are almost or altogether wanting. Such rocks have been designated binary granites, a term which it will be well to retain. Chloritic and talcose granites, into the composition of which chlorite and talc enter, need only be mentioned in this connection. The name of syenite, so often given to hornblendic granites, will, in accordance with the views already expressed, be restricted to rocks destitute of quartz. While the disappearance of this mineral from hornblendic granites is held to give rise to a true syenite, the same process with micaceous granites affords a quartzless rock, consisting of orthoclase and mica, for which we have no name. Great masses of an eruptive rock, granite-like in structure, and consisting of crystalline orthoclase or sanidin, without any quartz, occur in the province of Quebec. This rock contains in some cases a small admixture of black mica, and in others an equally small proportion of black hornblende. The latter variety might be described as syenite, but for the former we have no distinctive name, and I have described both of these by the name of granitoid trachytes, a term which I adopted the more willingly on account of the peculiar composition of the feldspar, and also because compact and finely granular rocks in the same region, having a similar chemical composition, present all the characters of typical trachytes, and apparently graduate into the granitoid rocks just noticed.* In all attempts to

* This Journal, II, xxxviii, 95. See also Zirkel, *Petrographie*, ii, 179.

define and classify compound rocks, it should be borne in mind that they are not definite lithological species, but admixtures of two or more mineralogical species, and can only be arbitrarily defined and limited.

§ 3. Having thus defined the mineral composition of granitic rocks, we proceed to notice their structure. Gneiss has the same mineral elements as granite, but is distinguished by the more or less stratified and parallel arrangement of its constituents, and lithologists are aware that in certain varieties of gneiss, this structure is scarcely evident except on a large scale; so that the distinction between gneiss and granite rests rather on geognostical than on lithological grounds. To the lithologist, in fact, the granitoid gneisses are simply more or less stratiform granites, while it belongs to the geologist to consider whether this structure has resulted from a sedimentary deposition, or from the flowing of a semi-fluid heterogeneous mass giving rise to a stratiform arrangement.

§ 4. The rocks having the mineralogical composition of granites present a gradual passage from the coarse structure of ordinary micaceous, hornblendic and binary granites to finely granular and even impalpable mixtures of the constituent minerals, constituting the rocks known as felsite, eurite and petrosilex. These rocks are often porphyritic from the presence of crystals of orthoclase, and sometimes of crystals or grains of quartz imbedded in the finely granular or impalpable paste. These felsites and felsite-porphyries are, in very many cases at least, stratified or indigenous rocks, and they are sometimes found associated with granular aggregates of different degrees of coarseness, which show a transition from true felsites into granitic gneisses. The resemblances in ultimate composition between felsites, granites and granitic gneisses are so close that it cannot be doubted that their differences are only structural.

§ 5. Felsites and felsite-porphyries are well known in eastern Massachusetts at Lynn, Saugus, Marblehead and Newburyport, and may be traced from Machias and Eastport in Maine, along the southern coast of New Brunswick to the head of the Bay of Fundy, with great uniformity of type, though in every place subject to considerable variations from a compact jasper-like rock to more or less coarsely granular varieties, all of which are often porphyritic from feldspar crystals, and sometimes include grains or crystals of quartz. The colors of these rocks are generally some shade of red, varying from flesh-red to purple; pale yellow, gray, greenish and even black varieties are however occasionally met with. These rocks are throughout this region distinctly stratified, and are closely associated with dioritic, chloritic and epidotic strata. They apparently belong, like these, to the great Huronian system.

§ 6. Many of the so-called granites of New England are true gneisses, as for example, those quarried in Augusta, Hallowell, Brunswick and many other places in Maine, which are indigenous rocks interstratified with the micaceous and hornblendic schists of the great White Mountain series. To this class also, judging from lithological characters, belong the so-called granites of Concord and Fitzwilliam, New Hampshire. These indigenous rocks are tenderer, less coherent, and generally finer grained than the eruptive granites, of which we have examples in the micaceous granite of Biddeford, Maine, and the hornblendic granites of Marblehead and Stoneham, Mass., and Newport, Rhode Island; in all of which localities the contact of the eruptive mass with the enclosing rock is plainly seen; as is also the case farther eastward, on the St. Croix and St. John Rivers in New Brunswick, and in the Cobequid Hills and elsewhere in Nova Scotia. The hornblendic granites of Gloucester, Salem and Quincy, Massachusetts, seem also, from their lithological characters, to belong to the class of exotic or true eruptive granites.* The farther discussion of the nature and origin of these gneisses and granites is reserved for another occasion, and we now proceed to notice the history of granitic veins.

§ 7. The eruptive granitic masses just noticed, not only include fragments of the adjacent rocks, especially near the line of contact, but very often send off dykes or veins into the surrounding strata. The relation of these with the parent mass is however generally obvious, and it may be seen that they do not differ from it except in being often finer grained. These injected or intruded veins are not to be confounded with a third class of granitic aggregates, which I have elsewhere described as granitic veinstones, or, to express their supposed mode of formation, endogenous granites. They are to the gneisses and mica-schists, in which they are generally enclosed, what calcite veins are to stratified limestones; and although long known, and objects of interest from their mineral contents, have generally been confounded with intrusive granites.

§ 8. Scheerer, in his famous essay on granitic rocks, which appeared in the Bulletin of the Geological Society of France in 1847, (vol. iv, p. 468), conceives the congealing granitic mass to have been impregnated with "a juice," which was nothing else than a highly heated aqueous solution of certain mineral matters. This, under great pressure, oozed out, penetrating even the stratified rocks in contact with the granite, filling cavities and fissures in the latter, and depositing therein crystals of quartz and of hornblende, the arrangement of which shows them to have been of successive growth. Neither Scheerer,

* T. S. Hunt on the Geology of Eastern New England, this Journal for July, 1870, p. 88; also Notes on the Geology of the vicinity of Boston, Proc. Boston Nat. Hist. Soc., Oct. 19, 1870.

nor Virlet d'Aout, who supported his views, however (*ibid.*, iv, p. 493) extended them to feldspathic veins, though Daubrée, at an earlier date, had described certain granitic veins in Scandinavia as having been formed by secretion rather than by igneous injection, as maintained by Durocher.

§ 9. Elie de Beaumont, starting from the hypothesis of a cooling liquid globe, imagined "a bath of molten matter on the surface of which the first granites crystallized." From the ruins of these were formed the first sedimentary deposits, but directly beneath were other granitic masses, which became fixed immediately afterward. "Some parts of these masses, coagulated from the commencement of the cooling process, but not completely solidified, were then erupted through the sedimentary deposits" just mentioned. "In these jets of pasty matter" were contained many of the rarer elements of the granitic magma, which were thus concentrated in the outermost portions of the granitic crust, and in the ramifications formed by these portions in the masses through which they were forced by the eruptive agents. Those portions of the granitic masses, and their ramifications, in which these rarer elements are concentrated, are distinguished from the rest of the masses alike by their exterior position and their peculiar structure. They are often coarse-grained and include the pegmatites, tourmaline-granites, and veins carrying cassiterite and columbite, often abounding in quartz. These mineral products are to be regarded as emanations from the granite, and are described as a *granitic aura*, constituting what Humboldt has called the penumbra of the granite. (*Bull. Soc. Geol. de France*, (2) iv, 1249. See particularly pages 1295, 1321 and 1323).

§ 10. While Fournet, Durocher and Rivière conceived the granitic magma to have been purely anhydrous, and in a state of simple igneous fusion, Elie de Beaumont maintained with Poulett-Scrope and Scheerer that water had in all cases intervened, and that a few hundredths of water might at low red heat have given rise to the condition of imperfect liquidity which he imagined for the material of the injected granites. The coarsely crystalline granitic veins were according to him veins of injection, and he speaks of them as examples in which "the phenomena essential to the formation of granite had been manifested with the greatest intensity." The granitic emanations, which are supposed to have furnished the material of these veins, appear to be regarded by him as the result of a process of eliquation from the congealing granitic mass. De Beaumont is careful to distinguish between them and those emanations which are dissolved in mineral waters or are exhaled as volcanic vapors, (page 1324). To the agency of such waters he ascribes the formation of concretionary veins, which are generally characterized by their symmetrically banded structure.

He further adds that granites, as to their mode of formation, offer a character intermediate between ordinary veins and volcanic and basic rocks. This is conceivable as regards granitic veins, since these, according to him, although formed by injection, and not by concretion, result from a process of emanation from the parent granitic mass, which may be described as a kind of segregation.

I have thus endeavored to give, for the most part in his own words, the views on the origin of granites enunciated by the great French geologist in his classic essay on Volcanic and Metalliferous Emanations, published in 1847. They belong to the history of our subject, and are remarkable as a clear and complete expression of those modified plutonic views which are probably held by a great number of enlightened geologists at the present time. My reason for dissenting from them, and the theories which I offer in their stead will be shown in the sequel.

§ 11. Élie de Beaumont, while regarding the formation of granitic veins as a process in which water intervened to give fluidity to the magma, was careful to distinguish the process from that of the production of concretionary veins from aqueous solution, and supposed the fissures to have been filled by the injection of a jet of pasty matter, derived from a consolidating granitic mass. Daubrée and Scheerer in describing the granitic veins of Scandinavia, conceive the material filling them to have been derived from the enclosing crystalline strata instead of an unstratified granitic nucleus, but do not, so far as I am aware, compare their formation to that of concretionary veins. Their publications on this subject, it should be said, are both anterior to the essay of de Beaumont.

§ 12. The notion that all granitic veins are the result ot some process of injection, and not to be confounded with concretionary veins, seems indeed to have been general up to the present time. Even von Cotta, while strongly maintaining the aqueous and concretionary origin of metalliferous veins in general, when describing those consisting of quartz, mica, feldspar, tourmaline, garnet and apatite, with cassiterite, wolfram, etc., which occur at Zinnwald and at Johanngeorgenstadt, is at a loss whether to regard these veins, from their granitic character, as igneous-fluid injections or as concretionary lodes. In support of the latter view he refers to their more or less regular and symmetrically banded structure, and while recalling the fact that mica and feldspar may both be formed in the humid way, considers the nature of these veins to be very problematical, and the question of their origin a difficult one.—(*Ore Deposits*, Prime's translation, 1870, pages 110–124).

§ 13. I have for several years taught that granitic veins of the kind just referred to are concretionary and of aqueous origin.

In 1863 I described certain veins in the crystalline schists of the Appalachian region of Canada, "where flesh-red orthoclase occurs so intermingled with chlorite and white quartz as to show the contemporaneous formation of the three species. The orthoclase generally predominates, often reposing upon or surrounded by chlorite; at other times it is imbedded in quartz, which covers the latter. Drusy cavities are also lined with small crystals of the feldspar, and have been subsequently filled with cleavable bitter-spar, sometimes associated with specular iron, rutile and sulphuretted copper ores." A study of these veins shows a transition from those "containing quartz and bitter-spar with a little chlorite or talc, through others in which feldspar gradually predominates, until we arrive at veins made up of orthoclase and quartz, sometimes including mica, and having the characters of a coarse granite; the occasional presence of sulphurets of copper and specular iron characterizing all of them alike. It is probable that these, and indeed a great proportion of quartzo-feldspathic veins are of aqueous origin, and have been deposited from solutions in fissures of the strata, precisely like metalliferous lodes. This remark applies especially to those granitic veins which include minerals containing the rarer elements. Among these are boron, phosphorus, fluorine, lithium, rubidium, glucinum, zirconium, cæsium, tin and columbium, which characterize the mineral species apatite, tourmaline, lepidolite, spodumene, beryl, zircon, allanite, cassiterite, columbite, and many others."—(*Geology of Canada*, p. 476, also p. 644.)

In this connection I referred to the occurrence of orthoclase with quartz, calcite, zeolites, epidote and native copper in certain mineral veins of Lake Superior, so well described by Prof. J. D. Whitney, (this Journal, II, xxviii, 16). The associations, according to him, show the contemporaneous crystallization of the copper, natrolite, calcite and feldspar, which last was found by analysis to be a pure potash-orthoclase.

§ 14. In 1864, this view was still farther insisted upon in this Journal, (II, xxxvii, 252), where, in speaking of mineral veinstones "which doubtless have been deposited from aqueous solution," it is added, "while their peculiar arrangement, with the predominance of quartz and non-silicated species generally serves to distinguish the contents of these veins from those of injected plutonic rocks, there are not wanting cases in which the predominance of feldspar and mica gives rise to aggregates which have a certain resemblance to dykes of intrusive granite. From these, however, true veins are generally distinguished by the presence of minerals containing boron, fluorine, phosphorus, cæsium, rubidium, lithium, glucinum, zirconium, tin, columbium, etc.; elements which are rare, or found only in minute quantities in the great mass of sediments, but are here accumulated by deposition from waters, which have removed these

elements from the sedimentary rocks and deposited them subsequently in fissures."

In the Report of the Geological Survey of Canada for 1865 (p. 192), I have, in describing the veins of the Laurentian rocks, insisted still farther on the distinction just drawn between granitic dykes and granitic veinstones, which latter I have proposed to call endogenous rocks to indicate the mode of their formation, and to distinguish them from intrusive or exotic rocks, and sedimentary or indigenous rocks.

§ 15. The peculiar banded arrangement which is so characteristic in concretionary veins not granitic in composition is probably not less marked in granitic veinstones, and often appears in these in a remarkable manner, showing that they have been formed by successive depositions of mineral matter, and generally in open fissures. This structure, and various peculiarities to be observed in granitic veinstones, will be best illustrated by descriptions of various localities, most of which I have personally examined. It is proposed to notice first, the veins of the gneiss and mica-schist series of New England, and secondly those of the Laurentian rocks of New York and Canada. In the latter class will be noticed the more or less calcareous veinstones into which the Laurentian granitic veins are found to graduate.

[To be continued.]

ART. XIV.—*On Siredon Metamorphoses, etc.;* by E. D. COPE.

THE late observations by various writers on the metamorphoses of Amblystoma, especially those of Mr. Tegetmeier, indicate that some of the principal facts in the history of the subject have been overlooked by all of them.

In the first place, no one has seen any metamorphosis of true Siredon, *Siredon Mexicanus* Shaw (*S. pisciformis*, *S. axolotl* and *S. maculatus* Auctorum) which inhabits the lakes of Mexico, and of which the Smithsonian collections contain numerous specimens. Whether it undergoes a metamorphosis is entirely unknown to naturalists, though I would express the belief that it will be found to do so occasionally, under suitable circumstances. No Amblystomæ have been brought from Mexico south of Tamaulipas and Chihuahua, by any of the various naturalists collecting for the Smithsonian Institution.

In the next place, Prof. Baird was aware of the metamorphoses of all the North American species of Siredons many years before the observation of it in the Jardin des Plantes, although at first he named one of them *Siredon lichenoides* treating it as a mature animal. He regarded these creatures as larvæ in his essay on the North American Salamanders, published in Philadelphia in 1847.

Thirdly, the important observation of Duméril* established the fact that the Siredons reproduced as such, and his account, of the subsequent loss of larval characters by the offspring, is the first of a positive character which we possess on that point.

After this, in 1867,† the writer recorded the various stages of metamorphosis in different structures, to be observed in reproducing individuals of two species of *Amblystoma*, viz: *A. tigrinum* and *A. mavortium*. These embraced various Siredon characters of the dental, branchial, and dermal organs, and of coloration. It was suggested that the metamorphoses observed by Duméril were those of *A. mavortium*, which was confirmed by an examination of specimens sent to the writer by Prof. Duméril,‡ a year afterward. At the same time the periods of metamorphosis of eight other species of the genus were stated, and the Mexican *axolotl* was regarded as an *Amblystoma*, whether undergoing metamorphosis or not, owing to the irregularity of its occurrence in the most nearly allied species, *A. mavortium*, or from its Siredon stage, *S. lichenoides* Baird.

In 1868 Prof. Marsh of Yale College observed the metamorphosis of the *A. mavortium*, confirming the conclusions of previous writers. Since that time the changes have been observed by Dr. Tegetmeier and others.

The only point remaining to be determined, is whether *Siredons* (i. e. *Amblystoma Mexicanum*) undergo a metamorphosis or not. Among our numerous specimens I can find none that exhibit any tendency toward the change.

I might add here that I have had for a time in a winter fernery, a large New Jersey specimen of *Amblystoma tigrinum*, a foot in length. It is nocturnal in its habits, and remains during the day in its burrow. This extends through the long diameter of its prison, and has three outlets, which it keeps open. From one of them, as evening approaches, it projects its head, and watches with attention what is transpiring in the room.

In the same case are specimens of the common *Plethodon cinereus* of both varieties. During this, as in former years, I observe that this species is nocturnal, and is a great climber. They will climb the rachis of a most slender fern, or spear of grass, and lie in a coil on the end of a tall frond or other narrow support, which may be sufficient to bear their weight, at a height of a foot or eighteen inches above the ground. They climb a plate of glass with great ease, by adhering closely to its smooth surface with their moist abdomen. When disturbed on some high perch among the herbage, they leap away by a sudden unbending of the coiled body, in the manner of some caterpillars.

* Bulletin Société d'Acclimatation, 1865, II, 348.
† Proceedings Acad. Nat. Sciences, Philad., 166.
‡ Origin of Genera, 1868, p. 47.

ART. XV.—*Lower Carboniferous Limestone in Ohio;* by Prof. E. B. ANDREWS.

FOR several years I have suspected that a certain limestone in southeastern Ohio should be classed with those of the Lower Carboniferous limestones. The supposition was entirely contrary to the "traditions of the elders," and furthermore, the limestone was *above* the principal range of conglomerate which has been ever regarded as true Coal-measure conglomerate. In the prosecution of the Ohio Geological Survey, in the 2d district, entrusted to me, I find that the conglomerate referred to is a Waverly conglomerate; that it is separated from the base of the productive Coal-measures by an upper Waverly sandstone group, rich in fossils, which I have called the *Logan sandstone group*, and that resting upon this group is, in many places, a limestone, called the *Maxville limestone*, which is a true Lower Carboniferous limestone. This limestone is not a continuous deposit but has only a local development here and there, always resting, however, upon the fine-grained Logan sandstone group. It was deposited in quiet basins along a uniform horizon. Generally, there is an iron ore adhering to the top of the limestone. There is no evidence that the local deposits were once continuous and united and were subsequently separated by erosion. The stratigraphical position of the limestone and the contained fossils led me to suspect that we had in it an Ohio representative of the Chester limestone of the Illinois Reports. This opinion has been confirmed. Prof. F. B. Meek, now engaged in the study of our Ohio fossils, has sent me the following report in regard to the fossils of the Maxville limestone:—

"*List of species and genera.*

1. *Zaphrentis.* A small undetermined curved conical species.
2. *Scaphiocrinus decadactylus* Hall? Described from the Chester group.
3. *Productus pileiformis* McChesney. Described from the Chester group. Thought by Mr. Davidson to be the same as *P. cora* d'Orbigny.
4. *Productus elegans* N. and P. Described from the Chester group. Some of the specimens may be the form Prof. McChesney described from the same horizon under the name *P. fasciculatus.*
5. *Chonetes.* Undetermined species.
6. *Athyris subquadrata* Hall. Described from the Chester (Kaskaskia) group.
7. *Athyris trinuclea* Hall. sp. Described from the St Louis (Warsaw) group.
8. *Spirifer* (*Martinia*) *contractus* M. and W. Described from the Chester group.
9. *Spirifer.* Undetermined fragments of perhaps two species.
10. *Terebratula.* An undetermined, small oval species showing the fine punctures under a lens.
11. *Aviculopecten.* Undetermined species.
12. *Allorisma.* Undetermined fragments, apparently like *A. antiqua* Swallow, described from the Chester group.
13. *Naticopsis.* A small undetermined species.
14. *Straparollus perspectivus* Swallow, sp. Probably a more elevated form of *S. planidorsatus* M. and W. Both were described from the Chester group.

15. *Bellerophon sublaevis* Hall. Described from the St. Louis (Warsaw) limestone.
16. *Pleurotomaria.* A small undetermined cast.
17. *Nautilus.* A small undetermined compressed, discoidal species with the very narrow periphery truncated.
18. *Nautilus.* A large sub-discoid undetermined species, with an open umbilicus and only slightly embracing volutions that are somewhat wider transversely than dorso-ventrally, and provided with a row of obscure nodes around near the middle of each side. Very nearly allied to *N. spectabilis* M. and W. from the Chester group, but more compressed and having narrower and apparently one or two more volutions. Specimens mere fragments."

In his letter Prof. Meek adds: "From these fossils, it is clearly evident that the limestone, from which they were obtained, belongs, as you had supposed, to the horizon of the Lower Carboniferous limestone series of the Western States. They also show that it does not belong to any of the inferior members of that series.

Of the 18 or 20 species of fossils sent from this rock, about one half are represented in the collection only by specimens that are too imperfect for specific identification; though none of them, so far as their characters can be made out, appear to be allied to known forms from any horizon below the St. Louis limestone.

Of the remaining species, five can be identified confidently with Chester forms, and three others are either identical with Chester species, or most closely allied to forms of that age. Hence we may safely say that eight of the species are *Chester types.* Two, however, seem to be identical with species described from the St. Louis limestone farther west.

From these facts I can scarcely doubt that we have in these local masses of limestone a representation of the Chester group of the Lower Carboniferous limestone series; though it is possible that there may also be some representation of the St. Louis limestone of the same series at some of the outcrops. * * *

The discovery of these beds is, I believe, the first indication we have had of the existence of any member of the Lower Carboniferous *limestone* series of the West in Ohio. They also seem to show that the old Carboniferous sea did not extend to this region during the deposition of any but the later members of the lower limestone series, although we know it had done so previously, that is, during the older Waverly period."

The largest and best development of the Maxville limestone is in Muskingum county, in the vicinity of Newtonville, where it is from 15 to 20 feet thick. Although here within the geographical limits of the productive coal-measures, it is well exposed in the deep valleys of Jonathan's creek and other tributaries of the Moxahala creek. It is also found in Perry, Hocking, Vinton, Jackson and Scioto counties.

A single analysis of the stone showed it to be a double carbonate of lime and magnesia.

ART. XVI.—*Brief Contributions to Zoölogy from the Museum of Yale College.* No. XI. *Descriptions of some imperfectly known and new Ascidians from New England;* by A. E. VERRILL.

(Continued from page 56.)

Cynthia stellifera Verrill, sp. nov. Figures 5, 6.

Body depressed, oval or elliptical, attached by a broad, expanded base, with thin edges. Integument firm, thick, and opaque, the surface uneven with irregular, imperfectly reticulated wrinkles, between which the surface is somewhat raised, producing an irregularly tessellated appearance, most conspicuous above; the raised parts are minutely granulous. A somewhat elevated, rounded ridge passes from the lowest end over the top and between the tubes, connecting them together. The tubes are quadrangular, low, truncate, nearly equal, a little divergent, situated toward the larger end, a little to one side, and separated by a space greater than their diameters; both have similar apertures, cross-shaped in partial expansion, and surrounded by four larger papillose lobes, between which there are many smaller ones (fig. 6, *b*).

5.

Color of the body, when living, reddish brown, ferruginous, or purplish brown, often yellowish toward the margin, the median ridge yellowish brown; apertures sometimes bright orange within, in the area immediately around the openings purplish, with minute, radiating streaks of flake-white; the four large lobes are brownish, with numerous small specks and streaks of flake-white, which often predominate over the ground-color.

6.*

The largest specimens are about an inch in length, and half an inch in breadth.

At New Haven Light and Savin Rock, near the entrance of New Haven Harbor, adhering to the under side of stones at low-water mark,—A. E. Verrill.

Cynthia monoceros.

Ascidia monoceros Möller, Index Mollusc. Groenlandiæ in Kroyer's Naturhist. Tidsskrift, iv, p. 95, 1842.

Cynthia condylomata Packard, Invert. of Lab., in Mem. Boston Soc. Nat. Hist., i, p. 277, 1867; Binney, op. cit., p. 19, Pl. xxiii, fig. 324, 1870.

An examination of Dr. Packard's original specimens shows that they are identical with Möller's species. It differs widely

* Figure 6.—*Cynthia stellifera* V.; *a*, view from above, natural size; *b*, view of one of the tubes from above, enlarged about three diameters.

from all others from the American coast in the elevated tubercles of the surface and the prominent, conical summit, between the tubes.

According to Möller the color is pale red, with red orifices.

It is an Arctic species, not yet observed south of Labrador, and the Banks of Newfoundland. From the latter locality I have seen many fine specimens, collected by T. M. Coffin and J. P. Haskell, some of them 3 inches high and ·75 in diameter.

Cynthia carnea Verrill. Figures 7, 8, 9.

Ascidia carnea Agassiz, Proc. American Assoc. for Adv. Sci., ii, p. 159, 1850, (description insufficient); Binney in Gould's Invertebrata of Mass., 2nd ed., p. 25, Pl. xxiv, figures 334. 335, 1870, (young).

? *Cynthia gutta* Stimpson, Proc. Boston Soc. Nat. Hist., iv, p. 231, 1852, (young); Binney, op. cit., p. 19, 1870.

Cynthia placenta (*pars*) Packard, Mem. Boston Soc. Nat. Hist., i. p. 277, 1867; Binney, op. cit., p. 19, Pl. xxiii, figure 322, 1870; Verrill, Amer. Journ. Sci., xlix, p. 424, 1870.

When adult, this species is often two or three inches high and about an inch broad at the base, which is broadly adherent and thin at the margin.

The body is elongated, subconical, cylindrical, or urn-shaped and swollen above the middle (fig. 7), according to the state of expansion, and very changeable in form. The integument is rough, thick, firm, opaque, and reticulated with deep wrinkles, which are very conspicuous in contraction, but less numerous at the base, the interstices are raised and thickly covered with small granules. The tubes are terminal, subequal, divergent, enlarged at the bases, moderately elongated, tapering to the tips, with small square apertures. The anal tube is generally the most bent, and a little the longest. In contraction the body is low, conical, or hemispherical, with the surface coarse and rough, conspicuously reticulated and granulated; the tubes form low, four-lobed verrucæ, covered with rough granulous papillæ; the apertures are cross-shaped.

The color, when living and expanded, is dark reddish brown, or orange-brown, darker below, the wrinkles lighter than the interstices and often salmon-colored; the upper parts, especially the summit between the apertures, are deep salmon. The apertures are orange-red or salmon-color within, and surrounded by a ring of bright red. The ovaries were filled with deep red eggs and embryos, and discharged the active tadpole-shaped larvæ early in September.

7.

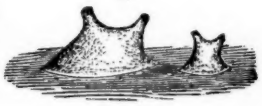
When younger the form is quite different (fig. 8), and when contracted corresponds in part with Packard's *C. placenta.** In expansion, however, the central

* By an examination of Dr. Packard's specimens I find that one of them belongs to a quite distinct species, having the surface minutely papillose and covered with closely adhering grains of sand.

portion of the body rises up and becomes prominent, subconical, rounded at the summit, and terminated by two prominent, nearly equal tubes, which are large at the base and taper rapidly to the square apertures. The base is broadly expanded, with a thin extended margin, and adheres very closely, so that it is often impossible to detach it without rupturing the integument. The ovaries are filled with bright red eggs and embryos, nearly the color of blood. The surface is wrinkled and reticulated nearly as in the adult, except that it is not so rough; the margin of the base is nearly smooth.

The color is similar to that of the adult, though usually lighter; the wrinkles are generally salmon-color and the raised interstices dull reddish brown; the upper part between the tubes lighter, often salmon-color; the apertures bright red or orange inside.

8.



When quite young (fig. 9) the body is very low and adheres by a broad base, which is very thin at the edge and expands in the form of a whitish margin around the slightly raised central part, which is oval or elliptical, and rounded above, in expansion, with the two small apertures on slightly raised tubes, one a little larger than the other. In contraction the body is nearly flat, the apertures sessile. In this state the integument is smooth at and near the margin, and only slightly roughened or indistinctly reticulated in the central parts. At a little earlier stage of growth it is entirely smooth.

The color is bright light red, deep pink-color, or blood-red, the raised interstices, when apparent, are deeper red; a bright pink or red line usually connects the two apertures, which are bright red; the thin margin of the base is whitish or light flesh-color, and transparent. The ovaries are filled, as in the older ones, with blood-red eggs and embryos. In this stage of growth it corresponds perfectly with *A. carnea* Agassiz, as figured by Binney, and probably with *A. gutta* Stimpson, though the latter may possibly be the similar young of some other species.

9.

Eastport Harbor, at extreme low-water of spring tides, under stones, rare; in 10 to 50 fathoms, on dead shells, stones, large ascidians, and *Modiola modiolus*, more common, but not abundant,—Expeditions of 1863, '64, '68, '70; South Bay, Lubec, 10 to 15 fathoms, shelly, not rare,—Exp. 1868, '70; off East Quoddy Light, young on smooth stones in 80 fathoms, abundant,—Exp. 1868; Off Head Harbor, Campo Bello I., in 100 to 120 fathoms, shelly,—Exp. 1870; Grand Menan, 15 to 20 fathoms,

shelly,—Exp. 1870; Labrador, 10 to 40 fathoms,—Packard; Massachusetts Bay,—L. Agassiz, W. Stimpson.

On the European coasts there are species that have similar young, which have also received in several cases specific names. Among these *C. grossularia* Van Ben., *C. limacina* Forbes and Hanley, and the young of *C. rustica* as figured in the Zoologica Danica (Tab. xv), may be mentioned, but I am not aware of any European species corresponding to the adult state of this. *C. rustica* seems, from the figures, to be the nearest allied species, but has a contracted base, is more cylindrical or subglobular, the upper portion is more decidedly tuberculose, the apertures are farther apart and less prominent, the inner tunic is light red, yellowish below, and it is represented as attached to seaweeds by root-like processes from the base. The young are similar to those of *C. carnea*, but show no marginal expansion. The original *rustica* of Linné was an arctic species and perhaps identical with this. I adopt the name, *carnea*, in preference to the others, because it is more applicable, although when first given it was not accompanied by a recognizable description.

Cynthia echinata.

Ascidia echinata Linn., Syst. Nat., ed. xii, p. 1087, 1767, (*non* Forbes and Hanley).*
Ascidia echinata Fabr., Fauna Groenl., p. 331, 1780; Rathke, Zoologica Danica, iv, p. 10, Pl. cxxx, fig. i, 1806; Möller, Index Mollusc. Groen., in Kroyer's Nat. Tidsskrift, iv, p. 95.
Cynthia echinata Stimpson, Invert. of Grand Menan, p. 20, 1854; Binney, op. cit., p. 18, Pl. xxiii, fig. 326.

Body subglobular, attached by a small basal disk. Integument firm, opaque, more or less wrinkled, the interstices enclosed by the wrinkles raised and lighter colored, the whole surface covered with velvet-like, fine, soft fibers; with numerous scattered elevated tubercles, each bearing a stellate cluster of 6 to 9 radiating, yellowish bristles, or flexible spines. The tubes are wide apart, terminal, small, subequal, a little elevated, both with small square apertures.

The color of the body, when freed from the foreign matters which are entangled and held firmly by the spines and fibers, is usually deep salmon, often more or less tinged with pink or flesh-color, and sometimes of a delicate flesh-color throughout. The apertures are red, often bright red with a lighter red ring; the tubes frequently have eight alternate light and deep red longitudinal stripes, extending from the edge to the base of the

* Two or more species have apparently been confounded under the name of *echinata*, owing to the peculiar stellate bristles with which they are covered. The *Ascidia echinata* of Forbes and Hanley (Brit. Mollusca, i, p. 35, Pl. C, fig. 4), if correctly figured, is a true *Ascidia*, very different from the present species, but covered with similar, though more distant, stellate bristles. It may be called, with propriety, *A. Forbesii*. The species described by Linnæus came from Iceland and is probably the same as that here described.

tubes, or four light stripes extending from the angles of the apertures down their sides.

The largest specimens observed are rather more than an inch in diameter; the tubes about ·10 of an inch high, and about the same in diameter at base; the apertures about ·05.

Eastport and Grand Menan at low-water under stones; and in 10 to 120 fathoms, not uncommon, attached to other ascidians, dead shells, stones, etc.,—Expeditions of 1859, '63, '64, '58, '60; Labrador.—Packard; Greenland,—Fabricius, Lütken; Norway, —Rathke; Iceland,—Linné; Grand Banks,—T. M. Coffin.

Cynthia pyriformis. Figure 10. "Sea Peach."

Ascidia pyriformis Rathke, Zoöl. Danica, iv, p. 41, Tab. clvi, figs. 1, 2; Möller, op. cit., Kroyer's Tidss., iv, p. 95, 1842.
Cynthia pyriformis Stimpson, Invert. Grand Menan, p. 20, 1853; Packard, op. cit., p. 277; Binney, op. cit., p. 17, Pl. xxiii, figs. 320, 321, 1870.

Form quite changeable, in expansion most frequently somewhat pear shaped or urn shaped, largest at or above the middle and somewhat smaller below; or subcylindrical and considerably elongated, with the top rounded; often in partial contraction subglobular, attached by a narrow base. When young the form is commonly nearly spherical, with a more or less narrowed basal attachment, and sometimes so constricted toward the base as to be slightly pedunculated. In large specimens there are usually more or less numerous, short, irregular, mostly lobed and divided rootlets, which originate close to the base. Tubes subcylindrical, large and prominent, terminal, near together at base, but divergent; the branchial one is largest and curves outward more or less abruptly; the anal is considerably smaller and swollen in the middle.

10.

Whole surface of the test minutely roughened or velvety, like the skin of a peach; it is covered with very small rounded granules or verrucæ, each of which bears a short flexible bristle or hair-like process; these, under the microscope, are found to give off minute sharp branches, directed forward, and irregularly placed; considerably larger bristles, of the same kind surround the apertures. In quite young specimens these bristles are larger and more conspicuous, being readily visible to the naked eye, and the apertures appear ciliated with the larger ones.

Color generally yellowish white, more or less tinged on the upper part and one side with peach-red; frequently yellowish white throughout, or merely tinged with orange in certain parts, especially between the tubes. Not unfrequently the color is deep orange-red or peach-red over most of the surface, except the lower part of the sides, which are flesh-color or salmon-color, and

a band of light orange bordered with darker orange-red, which passes from each tube down the sides to the base; a similar band or spot generally exists between the bases of the tubes. The apertures are salmon-color inside, often surrounded by a delicate circle of red, or in the darker specimens with a pale orange circle.

The larger specimens from Eastport are often 3 inches high in expansion, and 1 to 1·25 in diameter; diameter of the branchial orifice ·25; of anal ·15 of an inch. From the Banks of New Foundland I have seen specimens 3 inches in diameter.

Massachusetts Bay,—A. E. Verrill; Eastport and Grand Manan, from near extreme low-water mark of spring tides, under and among stones, to 50 fathoms, shelly and stony, common,—Expeditions of 1859, '63, '64, '68, '70; Off Head Harbor, 80 to 120 fathoms, gravelly and shelly bottoms, common,—Exp. 1870; Grand Menan,—Stimpson; Str. Belle Isle, Labrador, —Packard; Banks of New Foundland,—C. Foster, T. M. Coffin; Greenland,—Möller, Lütken; Norway,—Rathke, Sars.

Cynthia pulchella, sp. nov.

Body subglobular, attached by a small base. Test firm, opaque, smoothish, covered with minute, flatish, slightly raised, scarcely granular elevations, visible with a lens. Tubes slightly raised, terminal, not very near together; apertures small, square, nearly equal.

Color, in alcohol, purplish or grayish white, the apertures deeper purple. The specimens were not observed while living, and were probably similar in color to *C. pyriformis*, with which they were mixed.

Diameter ·12 to ·15 of an inch, probably young.

Eastport 10 to 20 fathoms, shelly,—Exp. of 1870.

The absence of rounded verrucæ and bristles on the test will readily distinguish this species from the last, which it otherwise most resembles.

Ascidia complanata Fabr. Figure 11.

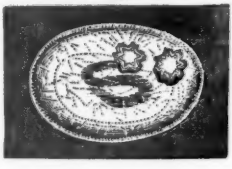
Ascidia complanata O. Fabricius, Fauna Grœnlandica, p. 332, 1780; Gmelin, Syst. Nat.

? *Ascidia orbicularis* Müller, Zool. Danica, ii, p. 53. Tab. 79, figs. 1, 2, 1788.

Ascidia callosa Stimpson, Proc. Boston Soc. Nat. Hist., iv, p. 228. 1852; Invert. Grand Manan, p. 19, 1853; Binney, op. cit., p. 26, pl. xxiii, fig. 318, 1870.

Test thick but translucent, oval or elliptical, depressed, adhering by the whole surface of the flattened left side; upper side slightly convex. In young specimens less than an inch long, the form is usually quite regular and the surface smoothish, with slight irregular wrinkles, more numerous around the tubes; in larger specimens the wrinkles become deeper, more numerous, and the surface correspondingly irregular and uneven,

11.



while the test becomes very thick and fleshy and covered with adhering worm tubes, bryozoa, hydroids, etc., and sometimes contains imbedded *Modiolariæ*. The tubes are both on the upper surface, low, sulcated, well separated, slightly divergent. The branchial tube is largest and near one end, a little to one side of the middle, often curved slightly forward, the sides with eight strong sulcations, the intervening ridges rough and often verrucose in large specimens; aperture with seven or eight lobes; each of the angles with a minute orange-red eye-spot. Anal tube smaller, low, subcylindrical, situated farther to one side, and about a third of the length from the anterior end, externally with six ribs and sulcations; aperture six-lobed, each of the angles with a minute orange eye-spot.

Color of the younger specimens pale, translucent, greenish or yellowish gray, or light horn-color, the mantle and dark intestine distinctly visible through the test; large specimens are darker greenish or olive-color, generally becoming more or less rusty brown or russet. Mantle finely speckled with raised yellowish points.

Some of the larger specimens are 4 or 5 inches long and 3 broad; ordinary ones 2 to 3 inches long, by 1 to 1·50 broad, and about ·50 high; height of tubes ·15 to ·25 of an inch; diameter ·15 to ·20.

Eastport, Me., and Grand Menan, at low-water mark under stones, in pools between tides, and at all depths to 120 fathoms, on stony bottoms, very abundant,—Expeditions of 1859, '61, '63, '64, '68, '70; Massachusetts Bay,—A. E. Verrill; Mt. Desert, Me., common,—A. E. Verrill; Labrador,—A. S. Packard; Greenland,—Fabricius, Möller; Grand Banks,—T. M. Coffin.

The younger specimens of this species appear to correspond perfectly with *A. complanata* of Fabricius.

Ciona tenella Verrill. Figures 12, 13.

Ascidia tenella Stimpson. Proc. Bost. Soc. Nat. Hist., iv. p. 228, 1853; Inv. of Grand Manan, p. 20, 1853; Binney, op. cit., p. 24, 1870.

? *Ascidia ocellata* Ag., Proc. Amer. Assoc. for Adv. Sci., ii, p. 159, 1850 (description insufficient); Binney, op. cit., p. 24, pl. xxiv, fig. 332, 1870.

12.

Body elongated, attached by the base, soft, flaccid, varying much in shape in different states of expansion. Tubes subcylindrical, terminal, approximate, a little elongated, the anal smaller and usually divergent, in some states longer, but in other cases shorter than the branchial. Test thin, smooth, transparent; mantle with conspicuous white longitudinal lines and fine transverse ones, the intestine and branchial sac showing through distinctly. At the base the test is often prolonged into short, root-like processes for attachment. Branchial orifice with eight rounded lobes and eight light orange eye-spots; from the angles

between the eyes eight conspicuous white lines pass down the sides. Anal orifice with six small lobes and six conspicuous eye-spots, like those of the branchial orifice.

13.

Color transparent whitish, with flake-white lines; mantle transparent, with whitish dendritic markings, not spotted, pale yellowish, deeper above.

The larger specimens are 3 inches long and ·75 in diameter, in expansion; more frequently the height is about 1·50, and the diameter about ·35 of an inch.

Eastport, and South Bay, Lubec, from low-water mark among stones, to 50 fathoms, stony and shelly bottoms, common,—Exp. of 1863, '64, '68, '70; off Head Harbor, 100 to 120 fathoms,—Exp. of 1868, '70; Grand Menan,—Stimpson, and Exp. of 1870; New Bedford, Mass.,—L. Agassiz.

This species is allied to *C. intestinalis* of Europe, and perhaps even more so to *C. fascicularis* Hancock, from Ireland.

ERRATA.—In the last number of this Journal, page 54, line 5, for *Molgula Manhattensis* Dekay, read *Ascidia Manhattensis* Dekay.

ART. XVII. — *On Insects inhabiting Salt Water.* No. 2. By A. S. PACKARD, Jr., M.D.

IN March, 1869, the writer published an article on this subject in the Proceedings of the Essex Institute, Salem, vol. vi, p. 41. Since then I have received an interesting collection of insects from Clear Lake, Lake Co., California, made by Prof. John Torrey, in 1865, and which he kindly placed in my hands for examination. Prof. A. E. Verrill has also allowed me to examine several puparia of Ephydra from Great Salt Lake, and during the past summer has dredged at the great depth of 20 fathoms at Eastport, Maine, a living Chironomus larva, undistinguishable from *C. oceanicus* Pack., found by me in great abundance at low-water mark in Salem harbor; and also a species of marine mite.

With the hope of awakening an interest among biologists in the subject of brine-inhabiting insects, and of receiving farther collections, especially from the salt lakes and salt works of this country, the following notes are published.

COLLECTION FROM CLEAR LAKE.

In the collection made in Clear Lake by Prof. Torrey, besides the halophilous larvæ and pupæ of Tanypus and Ephydra, were a number of bees, ichneumons, ants, and a species of Culex, the latter very abundant in the male sex, with several Muscids and Tipulæ; also a species of Chrysopa, and two species of

Coleoptera,* one a Stenus, and the other *Diabrotica soror* Lec., all of which were probably drowned from having accidentally fallen into the lake. In the collection, however, two truly aquatic beetles occurred, one, *Laccophilus decipiens* Lec., a Dytiscidan insect, and the other, *Berosus punctatissimus* Lec., a member of the family Hydrophilidæ. These probably lived in the brine not only in the adult, but also in the larval state.

Salda interstitialis Say, also occurred, and two other aquatic hemiptera: a new species of Hygrotrechus and Corixa, which are described by Mr. Uhler farther on.

Tanypus, sp.—The larvæ and pupæ of a species of Tanypus (or closely allied genus or subgenus), were abundant at Clear Lake. The body of the larva is long, slender, cylindrical, gradually tapering toward each end. The head is long and narrow, half as long as wide, and one half as long as the prothoracic segment. There are no rudiments of antennæ or maxillary palpi to be seen. In this respect it agrees with a species observed in fresh water at Salem, Mass. The mandibles are long and slender, with the ends very slender, acute, simple, untoothed, and well curved, forming two minute hooks capable of being extended a considerable distance in front of the head. The labium is broad and rounded in front, untoothed; it is situated a little in advance of the middle of the head, and is supported on a pair of slender chitinous pieces, not very approximate, with the outer ends opposite the posterior ocelli. The labrum is broad and rounded, overhanging the mouth. There are two pairs of ocelli situated a little behind the middle of the head; the anterior pair are the smaller and touch the hinder pair. A few hairs are scattered over the head. There are no prothoracic or anal feet, and no anal bristles, or appendages of any kind, not even the few long hairs observed in the Salem species. It is white and ·30 of an inch in length. Fig. 1, larva; 2, front and side view of the pupa.

Enlarged.

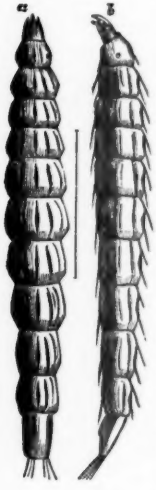
The pupa is rather slender, with the abdomen slightly flattened, and rather broad, being nearly as wide as the thorax. The wings and ends of the third pair of feet reach to the posterior edge of the second abdominal segment. The antennæ are laid in between the wings and the second pair of feet, disappearing under the middle of the front edge of the wing. The third pair of feet are concealed by the wings, the tips of the tarsi only being in sight; they are even with the end of the wings. The second pair of feet are entirely concealed, their tips not appearing, while the first pair are entirely in sight, their tips reaching nearly as far as those of the third pair. On the

* The Coleoptera were obligingly determined by Dr. Horn.

vertex is a pair of minute, acute spines, probably locomotive. From just above the base of the head, and in front of the insertion of the wings arises a pair of meso-thoracic respiratory tubes, which are broad and flat at their base, suddenly becoming cylindrical and slender a little beyond their middle, and projecting slightly beyond the head. The mesothorax is tergally full and rounded. The abdominal segments are very convex, with the sutures deeply marked, the edges of the segments being bevelled in toward the suture. The hinder edge of each ring is raised into an acute ridge, armed with a few short hairs. The terminal segment is slender, no wider than long, and with a small acute, terminal spine on each side. No respiratory appendages. It is whitish, with a yellowish tinge, and is ·15 of an inch in length. No adult Tanapus occurred in the collection.

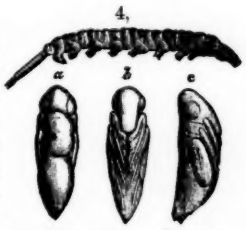
Stratiomys, sp. (Fig. 3 *a*, top view; *b*, side view).—With the young of Tanypus were associated several larvæ of this genus. They are long and slender, the body tapering alike toward both ends. The head is chitinous, sub-conical, and nearly as long as the prothoracic segment. On each side of the base of the head is a deep, slightly curved sinus (closed anteriorly in older specimens), thus forming a rather long tongue-like lobe to the under side of the head. Above, the head is divided by two deeply impressed lines into three lobes extending nearly to the posterior third of the head; these lobes are acutely pointed, the middle one being the longest, and embracing the clypeo-labral region. On the side of the outer lobes and at the middle of their length are situated the two ocelli. The antennæ are minute, acute tubercles situated at the ends of the outer lobes. The maxillæ (?) are two 2-jointed palpus-like appendages, with long hairs at the extremity, and play with much freedom up and down on the under side of the head, between the inner and outer lobes. Mandibles not distinguishable. The mouth parts are all inserted beyond the middle of the head.

3.



The body is rather flattened and broadest just in front of the middle; the segments are quite convex, with the sutures well marked. A pair of well marked stigmata on the prothoracic ring; none behind. The body is horn colored, paler beneath, with the integument densely punctured; the upper surface of the body is marbled with alternate light and dark streaks, in the middle of the body fading out in the middle of each segment, but toward the end of the body disappearing toward the sutures. On the side of each segment are four rows of minute dark dots, the upper row passing over the back at nearly

right angles, meeting the one opposite on the median line of the body. The anal segment is broad and flat, square at the tip, but a little rounded at the corners; it is nearly as long as the greatest width of the body. From a transverse terminal slit (not seen from above) projects a group of about ten radiating respiratory filaments, white and finely ciliated to the tip, the filaments being each a little over half as long as the anal segment. A little within the middle of this segment is a rather long slit, with thickened chitinous edges. A few hairs of varying length are scattered over the body. Length ·80 of an inch. This is, so far as I am aware, the first instance of the occurrence of this genus in salt water.



Ephydra Californica, n. sp. (Fig. 4; *a*, tergal, *b*, ventral, *c*, lateral view of the pupa.)—Several specimens of the larvæ of this species occurred, though the pupæ were far more numerous. Unfortunately none of the adults were found, but as the puparia are abundant and the flies could easily be reared from them, I venture to name the species.

The larva closely agrees with that of the European *E. riparia* Fallen, described by Loew, but has one more pair of abdominal legs, or tubercles. The body is white, long and slender, cylindrical, the sides of the segments bulging out, and each abdominal ring has three transverse, broad, flat tergal ridges; the thoracic segments being smooth above. The anterior end of the body, including the thoracic rings, tapers gradually, being subconical and truncated abruptly. The three thoracic segments are smooth, but minutely hairy on the anterior edge, the hairs being similarly arranged on the abdominal segments. The head is very small; the mandibles exist in the form of acute, curved, chitinous hooks, with a pair of papilliform antennæ (?) behind; and a pair of shorter tubercles (rudimentary palpi?) in front of them and just behind the mandibles.* The upper side of the body and base of the respiratory tubes are covered with very minute fine stiff hairs, and there is a row of them on the front edge of the prothoracic rings. On the front edge and on the sternal side of the mesothoracic ring is a dark chitinous,† transversely oblong area, with four clear pale dots, arranged in a transverse row, the space in front being broken up into chitinous spots; in other specimens this band is much narrower and less distinct. The integument on the tergal side

* These parts need to be studied in the living insect. They are not clearly defined in alcoholic specimens. I cannot discover the spigot-like stigmata on the prothorax described by Loew.

† By the term "chitinous" is meant any honey-yellow portion of the integument, hardened by the deposition of chitine. This term may be used to designate this honey-yellow color, instead of the very vague word testaceous.

of the body is a little thickened and chitinous. There are eight (Loew mentions only seven in *E. salinaria*) pairs of large abdominal fleshy non-articulated legs, like the abdominal fleshy legs of lepidopterous larvæ, ending in two curvilinear rows of well curved dark brown hooks, 5 or 6 in a row; on the terminal pair of feet are four rows, those of the fourth row being minute. The respiratory tube arises suddenly from the end of the terminal segment, stretching straight out posteriorly. The main portion of the tube is rather thick, and about as long as the body is thick. It is of the same thickness throughout; the terminal branches are about one-half as long as the main portion; they also arise suddenly like the joints of a telescope, not by the subdivision of the stalk, but by the sudden prolongation of the tracheæ with their surrounding membranes, and end in a minute nipple-like conical tip, separated by a deep suture from the end of the tube. These respiratory tubes vary in length in alcoholic specimens, as they are undoubtedly more or less retractile. Length including tube, ·50 inch; length of tube, ·15 inch.

The puparium differs from that of *E. halophila* Pack., from the Illinois salt-works, in being about a third larger, and in having a large, rounded tubercle on the side of the 9th and 10th segments, and sometimes a third situated higher up on the 9th ring. The seventh pair of feet are as large as the 6th, being large and quite long, while in *E. halophila*, they are scarcely larger than the five basal pairs. While in *E. halophila* the respiratory tube is not half as long as the body, in the present species it is fully half as long. As in that species they are attached to stalks of grass by curving the anal feet around them. Length ·55 inch; length of tube ·21 inch.

The pupa is white, naked, with the vertex of the head high between the eyes. The mouth parts form a broad, flattened, thick mass, pressed to the breast and reaching the anterior coxæ. Legs folded along the abdomen, the tarsi of the first pair reaching to the distal end of the posterior coxæ; the wings reach half way between the tarsi of the first and second pair of legs; the third pair do not quite reach to the end of the abdomen. At a later stage, when the integument is more chitinous, long hairs clothe the body; the mouth parts can be distinguished, and the legs are longer, the anterior tarsi reaching to the end of the wings, and the third pair of tarsi nearly to the end of the abdomen. All the appendages are enclosed in the pupal membrane of the earlier stage. The tarsal claws are now large and of mature form, while the wing veins can be readily traced. Length, ·25 inch.

Prof. A. E. Verrill has kindly loaned me specimens of the Ephydra, from Mono Lake, Cal., "a body of water not only excessively salt, but also strongly alkaline." These belong, so

far as the puparia indicate, to the above species. The puparium of *E. Californica* differs from that of *E. halophila*, in being about a third larger, and in having a large rounded tubercle on the side of the 9th and 10th segments of the body; while the seventh pair of feet are as large as the sixth, being in *E. halophila* scarcely larger than the five basal pairs. The respiratory tube is not half as long as the body in *E. halophila*. The Mono Lake specimens are ·55 inch long, and the respiratory tube ·21 inch.

Ephydra gracilis, n. sp.—These insects occur so abundantly where they are found, and can be so easily reared, that I venture to name another form from Great Salt Lake, specimens of the puparia of which have been communicated by Prof. Verrill, from the collection of Mr. Sereno Watson; and by S. A. Briggs, Esq., of Chicago. It is much smaller and slenderer than any of the preceding species, the smaller specimens being ·25 inch long, the largest ·50 inch. The respiratory tube is much longer than in any other species known to me, being in several specimens as long as the body itself; the branches into which it subdivides being over one-third as long as the base of the tube. The body is of the shape of *E. halophila*, but is much slenderer, while the feet are larger and more prominent.

Three specimens of heteropterous Hemiptera, from Clear Lake, were submitted to Mr. P. R. Uhler, who has kindly given me the following description of them.

Salda interstitialis Say. Jour. Acad. Philad., iv, p. 324.

A single ♀ specimen, from Clear Lake, California. If the specimen was taken out of the water, it had occurred there by accident. These insects do not live in the water; but affect the marshy ground sometimes adjacent to it. The specimen is immature, lacking the black color proper to the hemelytra and wings; but having the clavus, except at its tip, the base of the corium, and two or three streaks thereon black. The nervures of the membrane are simply brown.

Hygrotrechus robustus, n. sp.

One female of this genus (belonging to the family Hydrometridæ) very much mutilated, alone serves us for the present notice. In form it resembles *H. remigis* Say, but the abdomen is more uniformly robust towards the tip. The head is dark brown, fuscous on the middle, sericeous pubescent on the sides and beneath, with a pale arc on the impression at the base of the vertex. Antennæ robust, brownish-ochreous, the second joint just one-half as long as the basal one, the remaining ones destroyed. Rostrum brown, extending a very little way behind the anterior coxæ. Eyes pale brown, large. Thorax robust, pale brownish-testaceous, beneath brownish-ochreous, sericeous; the anterior lobe of pronotum blackish, divided in the middle

by an ochre-yellow line, each side between the eyes adjacent to them is an abruptly elevated, rufous tubercle; the mesial carinate line feeble, becoming obliterated posteriorly; humeri elongate-tuberculate, quite prominent; pleuræ darker than the pectus. Legs robust, brownish-ochreous. Hemelytra milky-white, as long as the abdomen, the nervures brownish-ochreous. Tergum pale ochreous, brown at base, the sutures and lateral raised edge brown; connexivum with a silvery, depressed dot adjoining each suture, the apical processes robust, of medium length, hardly acute. Venter smooth, dark ochreous.

Length to tip of processes 17 millims. Breadth across humeri 3 millims.

Corixa decolor, n. sp.*

Pale testaceous, dirty amber yellow above. Form of *C. hieroglyphica* Fieber, of Europe. Head large, cranium very convex, prominent, carinate on the middle, the vertex acutely produced. Face very deeply, concavely excavated, the cavity broad oval, occupying the whole width between the eyes and extending from near the upper edge of the eyes to the base of the clypeus, the middle of the excavation densely clothed with silvery hairs. Pronotum narrower than the head, almost twice as broad as long, the middle line feebly carinated anteriorly; the surface minutely rastrated, with about eight transverse, slender brown lines, each bounded in front by a faintly impressed line, the anterior line interrupted, the posterior one following the margin of the pronotum; the posterior margin triangularly rounding, extending pretty far back. Pleural pieces whitish; sternum honey-yellow. Anterior legs short, wide, pale honey-yellow, their tibiæ broad, compressed, blade-like on the anterior margin, oblong-oval, but little longer than the palæ; palæ subtriangular, a little longer than broad, fringed with long white ciliæ; the basal angles prominent, feebly rounded, the inner edge a little concave, tip acute. Intermediate and posterior legs slender, paler than the anterior ones, ciliæ and pubescence

* The fact that bread is made by the Mexicans from the eggs of a brine-inhabiting Corixa is noticed in Westwood's "Classification of Insects." Prof. O. C. Marsh has informed me that these brine insects are also noticed by M. Virlet d'Aoust in the Bulletin de la Société Geologique de France, 1858, xv, p. 200, and also by E. B. Tylor in his "Anahuac," London. 1861. The latter says "A favorite dish here [Tezcuco] consists of flies' eggs (*Corixa femorata* and *Notonecta unifasciata*, according to Menneville and Vielet d'Aoust) fried. These eggs are deposited at the edge of the lake, and the Indians fish them out, and sell them in the market place. So large is the quantity of these eggs that at a spot where a little stream deposits carbonate of lime, a peculiar kind of travertine is forming which consists of masses of them imbedded in the calcareous deposit."

The flies which produce these eggs are called by the Mexicans "Axayacatl" or water face. The eggs are sold in cakes in the market, pounded and cooked, and also in lumps *au naturel*, forming a substance like the roe of a fish. This is known by the characteristic name of "*ahua-uhtli*," that is, "water wheat."

In this connection we may remark that, according to the late Mr. Horace Mann, Jr., the Indians about Mono Lake eat large quantities of the puparia of *Ephydra*.

whitish. Hemelytra pale yellowish, the costal area whitish, the cross-nervule and a spot at tip brown; clavus at base with short, narrow brown lines running transversely from the outer and inner margins, beyond the middle to tip the lines run completely across; lines of the corium transverse, slender, slightly waved, many of the intermediate ones entire; membrane pale brown, with short, vermiculate, white lines. Venter and metasternum faintly dusky, the connexivum and genital segments whitish.

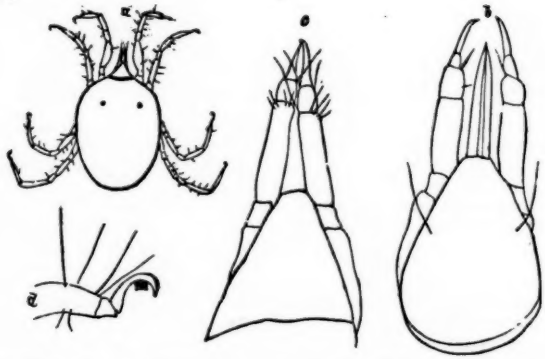
Length 4½ millims. Breadth across the pronotum 1½ millims. This species must be closely related to *C. Burmeisterii* Fieber, of Europe. The shape of the palæ and markings of the hemelytra of our species do not agree with Fieber's description. The specimen described is a male, which appears not to be fully mature. From Clear Lake.

MARINE INSECTS FROM DEEP WATER.

During his explorations at Eastport the past summer, Prof. Verrill dredged at the depth of 20 fathoms in Eastport harbor a larva of *Chironomus oceanicus* Pack. (Proc. Essex Inst., vol. vi, p. 42). It does not differ from specimens found by me at low-water mark in Salem harbor. It is evidently the same as the supposed larva of *Micralymma?*, mentioned and rudely figured in the American Naturalist, vol. ii, p. 278, found by me many years ago at low-water mark in Casco Bay. It is of the same size as the Salem specimens, being ·25 inch in length.

Thalassarachna Verrillii n. sp. (Fig. 5; *a*, head and mandibles and maxillary palpi; *c*, under side; *d*, anterior claw.—This

5.



species differs in important particulars from our best known species, *Hydrachna formosa* Dana and Whelpley (Amer. Journ. Sci., xxx, 354, 1836), found near New Haven, in fresh water Unionidæ. The body of that species is much longer, the

maxillary palpi are stouter and the relative length of the joints very different; the claws are very different, the forks of each claw being large and of equal size, and there is no brush on the base of the claw. At first I was disposed to place this halophilous species in the same genus as Dana and Whelpley's *Hydrachna formosa* and *H. pyriformis*, but having since then, through the kindness of Prof. Verrill, had the opportunity of studying a fresh-water mite closely allied to *H. formosa*, which is described below,* I am led to consider the salt-water mite as the type of a new genus, *Thalassarachna*, with the following differential generic characters; a conical head distinct from the rest of the body, maxillary palpi 5-jointed, each ending in an incurved spine, (the 5th joint). Mandibles large, forming an ensiform beak nearly as long as the palpi. Claws long, the upper hook minute, a single row of hairs on the under side of the lower hook, forming a brush. Otherwise closely allied to Hydrachna.

The body is globular, convex above, with the abdomen obtusely rounded behind; the skin being minutely lineated. It is blackish when alive, with the head and edge of the body white. The head is minute, conical, subacutely pointed in front. The maxillary palpi are 5-jointed, a little more than twice as long as the head, and about one-fourth as long as the fore legs. The second joint short; the third joint one-third as long as the entire palpus; the fourth as long as it is thick; the fifth minute and carrying a long, slender, slightly incurved spine bifid at the tip, the outer fork projecting considerably beyond the inner one. The mandibles form an ensiform acute beak, reaching to the middle of the terminal palpal spine. The two eyes are remote black dots situated on the anterior fourth of the body, over the insertion of the second pair of legs and just in front of them is a well marked transverse groove crossing the body. The legs are 6-jointed, much alike in structure, moderately hairy. The claws are alike in size, the hook being moderately curved, rather

* *Hydrachna tricolor*, n. sp. Under this name I describe a beautiful mite, brought me from New Haven by Prof. Verrill after the present article was sent for publication. It is ·07 inch in length, including the palpi. It is elliptical in form, a little broader behind, being two-thirds as broad as long. Ocelli situated over the insertion of the 2d pair of legs, the distance between them equal to half the width of the body. Body orange red, middle portion of the body black-brown, due to the color of the large liver, with a Y-shaped mesial line pale straw yellow in color, formed by the interspace between the two halves of the liver; the forks of the Y clavate. Appendages very pale grass-green. Legs much as in *H. formosa*, but the hairs are longer. Maxillary palpi the same as in *H. formosa*, there being two pairs of minute spines on the 4th palpal joints. Mouth and lancet-formed organ (languette) protruded as in *H. formosa*. "Bifid linguette" at the base of maxillary palpi, as in *H. formosa*. The rudimentary mandibles form a conical protuberance, the base situated within the body, each mandible being twice as long as broad, and reaching to the basal third of the 2d maxillary joint.

Twelve eggs, ten of them fully formed, being as long as the basal joints of the legs, could be seen on the under side of the body. The mite was alive Dec. 30, showing that the eggs, probably laid in the spring, are formed in the preceding autumn.

long, bifid at the end, the upper fork being much the smaller, especially on the anterior pairs, forming a small acute tubercle; in the middle of the under side of the claw (on all the feet) is a brush of fine hairs of equal length, arranged in a single row. On the penultimate joint of the anterior tarsi are five stout hairs; on the other tarsi three, the two proximal hairs being contiguous. External female genitalia with two bivalve contiguous plates, like those of *H. formosa* Dana and Whelpley. Length ·07 of an inch. The body of the young is whitish, longer, more ovate than in the adult; the abdomen being a little pointed behind.

With the exception of Philippi's *Pontarachna punctulatum* (Wiegmann's Archiv, vol. vi, p. 191, 1840, Pl. iv, fig. 4, 5), which was discovered by him in the bay of Naples (he does not state at what depth, consequently I infer that it was in shallow water), the species under consideration is the only one which, so far as I am aware, has been found to be exclusively marine. The genus Pontarachna is very different from Hydrachna and Thalassarachna, and I should judge that it rather approaches Atax. It differs from Thalassarachna in the shorter, unarmed palpi, and in the apparent (Philippi does not mention or figure them) absence of a mandibular beak. The palpi are half as long as the fore legs.

The present species was dredged by Prof. Verrill in 20 fathoms, on Clark's Ledge, in Eastport Harbor. It was found (four or five specimens, young and adult), "on hydroids," &c. It will be an interesting point to determine whether, like the other species of the genus, it also lives in the earlier, or even in the adult state among the gills of Lamellibranchs, and also whether it lives between tide marks, thus agreeing with the distribution of *Chironomous oceanicus*. At any rate we have here an insect and a mite breathing by tracheæ, and extracting the oxygen from the water at the great depth of 120 feet, and, in the case of the dipterous larva, with no apparent variation from specimens living at low-water mark. In this connection I might notice the fact that we have on our New England and Labrador shores several species of mites of the family Trombididæ, which run over seaweeds and live under stones between tide marks, and I have observed similar species at Beaufort, N. C., and Key West, Florida.

As regards the distribution of the species of brine insects, several questions of interest arise. How are we to account for the origin of the *Ephydra halophila* in such prodigious quantities in the vats of the Equality Salt Works of Illinois, a locality remote from salt lakes and the ocean shores? Are the brine species of the Salt Lakes of Utah and California, remnants of an oceanic fauna, and of the tertiary period, or are they of re-

cent and local origin? Have these brine insects acquired their singular tastes within a recent geological period (say the Quaternary), having lived at first as do their allied species, in foul fresh water, or amid decaying matter in damp localities? Before these and other questions can be answered, we must have analyses of the waters, and a review of the European literature of the subject,* and larger collections of brine animals from our own country.

Peabody Academy of Science, Salem, Nov. 16, 1870.

ART. XVIII.—*On the existence of the Nummulitic formation in China;* by Baron VON RICHTHOFEN. (From a letter to Prof. J. D. WHITNEY, dated Su-Chan, China, Dec. 12th, 1868).

THE subject of this letter is the discovery of the *occurrence of the Nummulitic formation in China*, a fact which adds one more to the short series of formations known, chiefly by the labors of Mr. Pumpelly, to enter into the composition of this country.

Mr. Pumpelly cites, on the strength of a statement by Rev. Mr. Edkins, the island of Si-Tung-ting in Tai-hu lake (a sheet of water of about eight hundred square miles, sixty miles west of Shanghai), as a fossiliferous locality. As he learned that the fossils were found in limestone, he was naturally led to the conclusion that this rock formed part of the wide-spread Devonian limestone. Inquiries which I made in Shanghai confirmed the fact of the occurrence of fossils. There, too, they were considered as Devonian, and I was advised by a really skillful geologist, to study their mode of occurrence, as this would give me the clue for the structure of most portions of

* I am indebted to Mr. F. Walker of London for the following note on the habits of the English species of Ephydra and its allies. He writes under date of Dec. 6, 1870. "I have observed species of Ephydra along the sea shore as well as several inland aquatic species. I am indebted to my friend, the late A. H. Haliday, for the descriptions of the species of this and the neighboring genera in my Diptera Britannica, vol. 2. I am not aware that the species are very different in their habits, and he does not mention them as such. He writes of the following species as occurring on the sea shore.

Heccameda albicans, on sandy coasts, especially on fresh rejectamenta.
Hydrellia thoracica, on the sea coast.
Atissa pygmæa, in a salt marsh.
Glenanthe ripicola, muddy sea coast.
Scatella sibillans, sea coast.
" *leucostoma*, marine rejectamenta.
" *æstuans*, among fuci.
" *despecta*, sea coast and sandy places.

Teichomyza fusca, on chalk cliffs a little above high water mark; swarms also occur in urinatories in London and other towns. Von Heyden, in the Entomologische Zeitung, Stettin, mentions *Cænia halophila* as a sea-side insect. I believe that no European Stratiomys has been discovered to live as a larva in sea brine."

China, in particular to the mode of occurrence of the Devonian limestone.

I consequently visited the place a few days ago, on a journey overland from Ningpo to Ching-kiang. As no limestone of more recent age than the Devonian was heretofore known in China, I was much surprised to meet with nummulites almost at first sight, and afterward I found the rock in places nearly made up of them. The rock is well exposed to view by enormous quarries, which appeared to have been worked for an immensely long time. The weathered surface of those fragments covering the more ancient waste-dumps shows the structure of the shells with remarkable distinctness, even the minute pores being clearly recognizable with a glass, so that there can not be the least doubt in regard to the true character of the fossil. Several species of Nummulina appear to be represented, as is indicated by the differences in shape of the cross-sections.

As Nummulites are characteristic only of one distinct part of the Eocene period, the fact of their occurrence should be sufficient evidence for the determination of the age of any rocks in which they are met with. But I found myself now in face of the strange fact, that it was partly on the strength of its fossils that the limestone in question had heretofore been considered as Devonian. I attempted therefore to collect its fauna more fully. I found the rock in places full of fossils, mostly bivalves and gasteropods, which have by no means a Paleozoic appearance. They are in an excellent state of preservation, the shells being only bleached. But the limestone is so hard and brittle that I destroyed nearly every specimen which I tried to save; yet I succeeded in getting a few good ones of bivalves. The forms of these fossils, as well as their state of preservation, reminded me much of similar occurrences in the Nummulitic limestone of Dalmatia. Besides gasteropods and bivalves, there occur corals and fragments of very large encrinites. Some of the former which I collected can probably be determined. But I failed to discover a single brachiopod, which are almost the only fossils supposed to be characteristic of the Devonian limestone of China. I presume that indistinct fragments of bivalves, which are usually all that can be obtained, have given rise to the belief of the occurrence of brachiopods on the Si-Tung-ting. Perhaps, too, real brachiopods may have been derived from other places in or near Tai-hu lake, as it is quite possible that true Devonian limestone may occur in the neighborhood.

The nummulitic limestone of Si-Tung-ting is very bituminous. It is burnt in kilns and emits a remarkably strong smell. Its thickness cannot be accurately determined, but it is certainly not more than six hundred feet. Its beds are nearly horizontal,

and rest on ancient sandstones, the strata of which are inclined at an angle of about twenty degrees. These sandstones are supposed by Mr. Kingsmill to have a thickness of about ten thousand feet.

Before visiting Si-Tung-ting, I had observed the occurrence of limestone in the neighborhood of the sea coast, near Hang-chau in the province of Che-Kiang, a place mentioned in Mr. Pumpelly's list of localities distinguished by the occurrence of useful minerals. As it rests there quite unconformably on sandstone similar to that which underlies it at Tung-ting, and has a similar lithological character, I believe that I may safely refer it to the same formation with that of Tung-ting. I shall hence look out for its further distribution in China. The subject is not without some practical interest, in a country where all limestone was assumed to underlie the coal and iron-bearing formations.

In 1861, the easternmost place where the Nummulitic formation was known to occur was northern India. I succeeded in that year in proving its existence so far east as Japan and the Philippines, a notice of which you may find in a paper published in the Jahrbuch der deutschen geologischen Gesellschaft of 1861 or 1862. I do not know whether the same formation has since then been found in the regions intermediate between those two countries and India. The occurrence in lake Tai-hu is one of the connecting links, and it is now quite likely that this interesting formation, occurring in places so far apart, is among the most widely distributed in Eastern Asia; and it is quite possible that one unbroken area of submergence may be proved to have extended during the short existence of the genus Nummulina, from Spain to the Philippines and Japan.

I may add, as a sort of voucher for the correctness of my observation, that its communication places me into the disagreeable position of taking opposite views from those of Mr. Kingsmill, a gentleman who has, besides his professional activity as architect in Shanghai, worked of late years with admirable success in the geology of some parts of China. He informed me, some time before I visited Tung-ting, that he had sent a paper on the geology of that locality to the London Geological Society, in the Journal of which it may be printed by this time. The views which he informed me he had taken therein are, that the limestone of Tung-ting is Devonian or Subcarboniferous, and that the great sandstone formation, which plays a very important part in the geology of Eastern China, preceded it in age. The relations observed at Si-Tung-ting do no longer justify this conclusion, after the discovery of the nummulites, and the age of the sandstone (Tung-ting-grits of Mr. Kingsmill) must therefore be considered as not yet safely

established. Mr. Kingsmill has, however, succeeded in collecting some remains of plants in the upper layers of the sandstone, and it is to be hoped that they will suffice to determine its age. The state of the weather prevented me from hunting for the locality where he found them.

ART. XIX.—*Note on the Infusoria Flagellata and the Spongiæ Ciliatæ;* by Prof. H. JAMES-CLARK, Kentucky University, Lexington, Ky.

I send this note in hopes that it may be of interest to those readers of this Journal who have followed the recent discussions upon spontaneous generation and the doctrine of evolution. It is an effort to clear up the chaos of uncertainty which has reigned among the lower Protozoa for years past, and particularly in the heterogeneous group of so-called Sponges. The aim of the Evolutionists is clearly, by refusing to recognize their truly organized structure, to depress these creatures to such a low level in grade, that they shall appear but a step above the lifeless protoplasm which some think has been seen *almost* manufactured in the laboratory of the chemist. After hypothetically developing "organizable protoplasm" out of "inferior types of organic substances," which in the process, *per se*, under "the mutual influences" of its metamorphic forms, generates still more *sensitive* organic matter, until it finally attains to the possession of *vital* actions, the evolutionist imagines himself able "deductively to bridge the interval" between the so-called "nascent life" and the unmistakable vitalism of the slimy Rhizopod (see Herbert Spencer, Appleton's Journal, Aug. 7th 1869, p. 598.)

My own researches have constantly tended in the opposite direction. In spite of the apparent physical simplicity of even the lowest of the Protozoa (Amœba and the like), their habits and the phenomena attendant upon their mode of locomotion, their determinate prehensile acts, so wonderfully like consciousness of an end to be accomplished, and their undeniably specialized digestive functions, all lead to the conclusion, which with me is a fact, that they possess a degree of differentiation in *esse* as marked as that which we recognize as *potential* in the earliest stage of the vertebrate embryo. In the former, the organization is present, but not circumscribed into regions; in the latter it is also present uncircumscribed, but it is to be eventually differentiated. The Sponges, with their supposed slimy, protoplasm-like simplicity, have been in former years the hunting ground of the developmentalists, but of late, that

group has been slipping out from under the feet of those philosophers.

Carter first detected the true *criterion* of their animality, though erring as to their classificatory relationship. It was my good fortune to prove their close alliance with the *Flagellata*, in a memoir (Mem. Boston Soc. Nat. Hist., vol. i, pt. III, Sept. 1867, *On the Spongiæ Ciliatæ as Infusoria Flagellata*), published some few years ago. I described certain monad-like infusoria which possessed a single *flagellum* surrounded by a projecting membranous collar. Some forms were appended to branching stems (*Codosiga*) and others were ensheathed in a funnel-shaped or urnæform tube (*Salpingœca*). The monadiform body of these I showed to be identical with the ciliate bodies of one of the *Spongiæ Ciliatæ* (*Leucosolenia*), and homologised the branching stem and the ensheathing tubes of the former with the gelatinous mass of the latter, into which its monads were imbedded. The connection seemed not even a step wide, so clear and unmistakable was the relationship. That there should ever be discovered a form which would lie so intermediate between these as to make me hesitate whether it belonged to the one or the other, I did not even hope for; but it has come unexpectedly. In Schultzes Archiv. für Mikroskopische Anatomie, (Bd. VI, 4, 1870), Cienkowsky describes, under the name *Phalansterium*, a genus which consists of monad-like bodies with a *flagellum* and a projecting collar like those of *Codosiga*, *Salpingœca* and *Leucosolenia*. Of the two species which he illustrates, one (*P. consociatum*) has monads enveloped in a broad funnel-shaped, slimy sheath, and these sheaths are closely packed side by side, radiatingly, so as to form a shield-like or a hemispherical mass. This comes nearest to the *Salpingœca*. The other species (*P. intestinum*) possesses similar monads, but they are imbedded basally in a gelatinous, intestiniform mass of slime (*Schleim*) "with their vibrating lashes extending in every direction" about the cylindrical colony. Originally each monad is endowed with a separate slime-sheath; but eventually these all are fused together into one common mass. Beyond this, to make a true Sponge we need but the presence of spiculæ, and open interspaces in the slimy mass, between the monads, leading to one common cavity. Introvert the layer of monads and we produce the desired effect without doing violence to their relative positions. It is a mere matter of proportions, just as the inverted cyathiform rose-hip is none the less an ovariferous disc than the globular receptacle of the strawberry.

ART. XX.—*Memoir of Thomas Graham;* by Prof. JOSIAH P. COOKE, Jr.*

IT would be difficult to find in the history of science a character more simple, more noble, or more symmetrical in all its parts than that of THOMAS GRAHAM, and he will always be remembered as one of the most eminent of those great students of nature, who have rendered our Saxon race illustrious. He was born of Scotch parents in Glasgow in the year 1805, and in that city, where he received his education, all his early life was passed. In 1837 he went to London as Professor of Chemistry in the newly established London University now called University College, and he occupied this chair until the year 1855, when he succeeded Sir John Herschel as Master of the Royal Mint, a post which he held to the close of his life. His death, on the 16th of September last, at the age of sixty, though occasioned by a severe cold, was really the wearing out of a constitution enfeebled in youth by excessive labor, voluntarily undertaken and courageously borne, that he might devote his life to scientific study. As with all earnest students, that life was uneventful, if judged by ordinary standards; and the records of his discoveries form the only materials for his biography. Although one of the most successful investigators of Physical Science, the late Master of the Mint had not that felicity of language or that copiousness of illustration, which added so much to the popular reputation of his distinguished contemporary, Faraday; but his influence on the progress of science was not less marked or less important. Both of these eminent men were for a long period of years best known to the English public as teachers of Chemistry, but their investigations were chiefly limited to physical problems; yet, although both cultivated the border ground between Chemistry and Physics, they followed wholly different lines of research. While Faraday was so successfully developing the principles of electrical action, Graham with equal success was investigating the laws of molecular motion. Each followed with wonderful constancy, as well as skill, a single line of study from first to last, and to this concentration of power their great discoveries are largely due.

One of the earliest and most important of Graham's investigations, and the one which gave the direction to his subsequent course of study, was that on the diffusion of gases. It had already been recognized that impenetrability in its ordinary sense is not, as was formerly supposed, a universal quality of matter. Dalton had not only recognized that aëriform bodies exhibit a positive tendency to mix, or to penetrate through each other, even in op-

* From the Proceedings of the American Academy of Arts and Sciences, vol. viii, May 24, 1870.

position to the force of gravity, but had made this quality of gases the subject of experimental investigation. He inferred, as the result of his inquiry, "that different gases afford no resistance to each other; but that one gas spreads or expands into the space occupied by another gas, as it would rush into a vacuum; at least, that the resistance which the particles of one gas offer to those of another is of a very imperfect kind, to be compared to the resistance which stones in the channel of a stream oppose to the flow of running water." But although this theory of Dalton was essentially correct and involved the whole truth, yet it was supported by no sufficient evidence, and he failed to perceive the simple law which underlies this whole class of phenomena.

Graham, "on entering on this inquiry, found that gases diffuse into the atmosphere with different degrees of ease and rapidity." This was first observed by allowing each gas to diffuse from a bottle into the air through a narrow tube in opposition to the solicitation of gravity. Afterwards an observation of Doebereiner on the escape of hydrogen gas by a fissure or crack in a glass receiver caused him to vary the conditions of his experiments, and led to the invention of the well known "Diffusion Tube." In this simple apparatus a thin septum of plaster of Paris is used to separate the diffusing gases, which, while it arrests in a great measure all direct currents between the two media, does not interfere with the molecular motion. Much later, Graham found in prepared graphite a material far better adapted to this purpose than the plaster, and he used septa of this mineral to confirm his early results, in answer to certain ill-considered criticisms in Bunsen's work on Gasometry. These septa he was in the habit of calling his "atomic filters." By means of the diffusion tube Graham was able to measure accurately the relative times of diffusion of different gases, and he found that *equal volumes of any two gases interpenetrate each other in times which are inversely proportional to the square roots of their respective densities*, and this fundamental law was the greatest discovery of our late foreign associate. It is now universally recognized as one of the few great cardinal principles which form the basis of physical science.

It can be shown, on the principles of pneumatics, that gases should rush into a vacuum with velocities corresponding to the numbers which have been found to express their diffusion times; and, in a series of experiments on what he calls the "*Effusion*" of gases, Graham confirmed by trial this deduction of theory. In these experiments a measured volume of the gas was allowed to find its way into the vacuous jar through a minute aperture in a thin metallic plate, and he carefully distinguished between this class of phenomena and the flowing of gases through capillary tubes into a vacuum, in which case,

however short the tube, the effects of friction materially modify the result. This last class of phenomena Graham likewise investigated, and designated by the term "Transpiration."

While, however, it thus appears that the results of Graham's investigation were in strict accordance with Dalton's theory, it must also be evident that Graham was the first to observe the exact numerical relation which obtains in this class of phenomena, and that all-important circumstance entitles him to be regarded as the discoverer of the law of Diffusion. The law, however, as first enunciated, was purely empirical, and Graham himself says that something more must be assumed than that gases are vacua to each other, in order to explain all the phenomena observed; and according to his original view this representation of the process was only a convenient mode of expressing the final result. Such has proved to be the case.

Like other great men, Graham built better than he knew. In the progress of physical science during the last twenty-five years, two principles have become more and more conspicuous, until at last they have completely revolutionized the philosophy of Chemistry. In the first place it has appeared that a host of chemical as well as of physical facts are coördinated by the assumption that all substances in the state of gas have the same molecular volume, or, in other words, contain the same number of molecules in a given space; and in the second place, it has become evident that the phenomena of heat are simply the manifestations of molecular motion. According to this view, the temperature of a body is the *vis viva* of its molecules; and, since all molecules at a given temperature have the same *vis viva*, it follows that the molecules must move with velocities which are inversely proportional to the square roots of the molecular weights. Moreover, since the molecular volumes are equal, and the molecular weights therefore proportional to the densities of the aëriform bodies in which the molecules are the active units, it also follows that the velocities of the molecules in any two gases are inversely proportional to the square roots of their respective densities. Thus the simple numerical relations first observed in the phenomena of diffusion are the direct result of molecular motion, and it is now seen that Graham's empirical law is included under the fundamental laws of motion. His investigation has become the basis of the new science of molecular mechanics, and his measurements of the rates of diffusion prove to be the measures of molecular velocities.

From the study of diffusion, Graham passed by a natural transition to the investigation of a class of phenomena, which, although closely allied to the first, as to the effects produced, differ wholly in their essential nature. Here also he followed in the footsteps of Dalton. This distinguished chemist had noticed that a bubble of air separated by a film of water from

an atmosphere of carbonic anhydride, gradually expanded until it burst. In like manner a moist bladder, half filled with air, and tied, if suspended in an atmosphere of the same material, becomes in time greatly distended by the insinuation of this gas through its substance. This effect cannot be the result of simple diffusion; for it is to be remembered that the thinnest film of water, or of any liquid, is absolutely impermeable to a gas as such; and, moreover, only the carbonic anhydride passes through the film, very little or none of the air escaping outward. The result depends, first, upon the solution of the carbonic anhydride by the water on one surface of the film; secondly, on the evaporation into the air, from the other surface, of the gas thus absorbed. Similar experiments were made by Drs. Mitchell and Faust, and others, in which gases passed through a film of india-rubber, entering into a partial combination with the material on one surface, and escaping from it on the other.

Graham not only considerably extended our knowledge of this class of phenomena, but also gave us a satisfactory explanation of the mode in which these remarkable results are produced. He recognized in these cases the action of a feeble chemical force, insufficient to produce a definite compound, but still capable of determining a more or less perfect union, as in the case of simple solution. He also distinguished the influence of mass in causing the formation or decomposition of such weak chemical compounds. The conditions of the phenomena under consideration are simply these:—

First. A material for the septum capable of forming a feeble chemical union with the gas to be transferred.

Secondly. An excess of the gas on one side of the film and a deficiency on the other.

Thirdly. Such a temperature that the unstable compound may form at the surface, where the aëriform constituent is present in large mass, while it decomposes at the opposite surface, where the quantity is less abundant.

One of the most remarkable results of Graham's study of this peculiar mode of transfer of aëriform matter through the very substance of solid bodies was an ingenious method of separating the oxygen from the atmosphere. The apparatus consisted simply of a bag of india-rubber, kept distended by an interior framework, while it was exhausted by a Sprengel pump. Under these circumstances the selective affinity of the caoutchouc determines such a difference in the rate of transfer of the two constituents of the atmosphere that the amount of oxygen in the transpired air rises to forty per cent, and by repeating the process nearly pure oxygen may be obtained. It was at first hoped that this method might find a valuable application in the arts, but in this Graham was disappointed; for the same result

has since been effected by purely chemical methods, which are both cheaper and more rapid.

These experiments on india-rubber naturally led to the study of similar effects produced with metallic septa, which, although to some extent previously observed in passing gases through heated metallic tubes, had been only imperfectly understood. Thus, when a stream of hydrogen or carbonic oxide is passed through a red-hot iron tube, a no inconsiderable portion of the gas escapes through the walls. The same is true to a still greater degree when hydrogen is passed through a red-hot tube of platinum, and Graham showed that through the walls of a tube of palladium hydrogen gas passes, under the same conditions, almost as rapidly as water through a sieve. Moreover, our distinguished associate proved that this rapid transfer of gas through these dense metallic septa was due, as in the case of the india-rubber, to an actual chemical combination of its material with the metal, formed at the surface, where the gas is in excess, and as rapidly decomposed on the opposite face of the septum. He not only recognized as belonging to this class of phenomena the very great absorption of hydrogen by platinum plate and sponge in the familiar experiment of the Doebereiner lamp, but also showed that this gas is, in some cases at least, a definite constituent of meteoric iron,—a fact of great interest from its bearing on the meteoric theory.

We are thus led to Graham's last important discovery, which was the justification of the theory we have been considering, and the crowning of this long line of investigation. As may be anticipated from what has been said, the most marked example of that order of chemical compounds, to which the metallic transpiration of aëriform matter we have been considering is due, is the compound of palladium with hydrogen. Graham showed that when a plate of this metal is made the negative pole in the electrolysis of water, it absorbs nearly one thousand times its volume of hydrogen gas,—a quantity approximately equivalent to one atom of hydrogen to each atom of palladium. He further showed that the metal thus becomes so profoundly altered as to indicate that the product of this union is a definite compound. Not only is the volume of the metal increased, but its tenacity and conducting power for electricity are diminished, and it acquires a slight susceptibility to magnetism, which the pure metal does not possess. The chemical qualities of this product are also remarkable. It precipitates mercury from a solution of its chloride, and in general acts as a strong reducing agent. Exposed to the action of chlorine, bromine, or iodine, the hydrogen leaves the palladium and enters into direct union with these elements. Moreover, although the compound is readily decomposed by heat, the gas cannot be expelled from the metal by simple mechanical means.

These facts recall the similar relations frequently observed between the qualities of an alloy and those of the constituent metals, and suggest the inference made by Graham, that palladium charged with hydrogen is a compound of the same class, —a conclusion which harmonizes with the theory long held by many chemists, that hydrogen gas is the vapor of a very volatile metal. This element, however, when combined with palladium, is in a peculiarly active state, which sustains somewhat the same relation to the familiar gas that ozone bears to ordinary oxygen. Hence Graham distinguished this condition of hydrogen by the term "Hydrogenium." Shortly before his death a medal was struck at the Royal Mint from the hydrogen palladium alloy in honor of its discovery; but although this discovery attracted public attention chiefly on account of the singular chemical relations of hydrogen, which it brought so prominently to notice, it will be remembered in the history of science rather as the beautiful termination of a life-long investigation, of which the medal was the appropriate seal.

Simultaneously with the experiments on *gases*, whose results we have endeavored to present in the preceding pages, Graham carried forward a parallel line of investigation of an allied class of phenomena, which may be regarded as the manifestations of molecular motion in *liquid* bodies. The phenomena of diffusion reappear in liquids, and Graham carefully observed the times in which equal weights of various salts dissolved in water diffused from an open-mouth bottle into a large volume of pure water, in which the bottle was immersed. He was not, however, able to correlate the results of these experiments by such a simple law as that which obtains with gases. It appeared, nevertheless, that the rate of diffusion differs very greatly for the different soluble salts, having some relation to the chemical composition of the salt which he was unable to discover. But he found it possible to divide the salts into groups of equi-diffusive substances, and he showed that the rates of diffusion of the several groups bear to one another simple numerical ratios.

More important results were obtained from the study of a class of phenomena corresponding to the transpiration of gases through india-rubber or metallic septa. These phenomena, as manifested in the transfer of liquids and of salts in solution through bladder, or a similar membrane, had previously been frequently studied under the names of exosmose and endosmose, but to Graham we owe the first satisfactory explanation. As in the case of gases, he referred these effects to the influence of chemical force, combination taking place on one surface of the membrane, and the compound breaking up on the other, the difference depending, as in the previous instance, on the influence of mass. He also swept away the arbitrary distinctions

made by previous experimenters, showed that this whole class of phenomena are essentially similar, and called this manifestation of power simply "osmose."

While studying osmotic action, Graham was led to one of his most important generalizations,—the recognition of the crystalline and amorphous states as fundamental distinctions in chemistry. Bodies in the first state he calls crystalloids; those in the last state, colloids (resembling glue). That there is a difference in structure between crystalloids, like sugar or feldspar, and colloids, like barley candy or glass, has of course always been evident to the most superficial observer; but Graham was the first to recognize in these external differences two fundamentally distinct conditions of matter not peculiar to certain substances, but underlying all chemical differences, and appearing to a greater or less degree in every substance. He showed that the power of diffusion through liquids depends very much on these fundamental differences of condition,—sugar, one of the least diffusible of the crystalloids, diffusing fourteen times more rapidly than caromel, the corresponding colloid. He also showed that, in accordance with the general chemical rule, while colloids readily combine with crystalloids, bodies in the same condition manifest little or no tendency to chemical union. Hence in osmose, where the membranes employed are invariably colloidal, the osmotic action is confined almost entirely to crystalloids, since they alone are capable of entering into that combination with the material of the septum on which the whole action depends.

On the above principles Graham based a simple method of separating crystalloids from colloids, which he called "dialysis," and which was a most valuable addition to the means of chemical analysis. A shallow tray, prepared by stretching parchment paper (an insoluble colloid) over a gutta-percha hoop, is the only apparatus required. The solution to be "dialyzed" is poured into this tray, which is then floated on pure water, whose volume should be eight or ten times greater than that of the solution. Under these conditions the crystalloids will diffuse through the porous septum into the water, leaving the colloids on the tray, and in the course of a few days a more or less complete separation of the two classes of bodies will have taken place. In this way arsenious acid and similar crystalloids may be separated from the colloidal materials with which, in the case of poisoning, they are usually found mixed in the animal juices or tissues.

But besides having these practical applications, the method of dialysis in the hands of Graham yielded the most startling results, developing an almost entirely new class of bodies as the colloidal forms of our most familiar substances, and justifying

the conclusion that the colloidal as well as the crystalline condition is an almost universal attribute of matter. Thus, he was able to obtain solutions in water of the colloidal states of aluminic, ferric, chromic, stannic, metastannic, titannic, molybdic, tungstic, and silicic hydrates, all of which gelatinize under definite conditions like a solution of glue. The wonderful nature of these facts can be thoroughly appreciated only by those familiar with the subject, but all may understand the surprise with which the chemist saw such hard, insoluble bodies as flint dissolved abundantly in water and converted into soft jellies. These facts are, without doubt, the most important contributions of Dr. Graham to pure chemistry.

In this sketch of the scientific career of our late Associate, we have followed the logical, rather than the chronological, order of events, hoping thus to render the relations of the different parts of his work more intelligible. It must be remembered, however, that the two lines of investigation we have distinguished were in fact interwoven, and that the beautiful harmony which his completed life presents was the result, not of a preconceived plan but of a constant devotion to truth, and a child-like faith, which unhesitatingly pressed forward whenever nature pointed out the way.

Although the investigations of the phenomena connected with the molecular motion in gases and liquids were by far the most important of Dr. Graham's labors, he also contributed to chemistry many researches which cannot be included under this head. Of these, which we may regard as his detached efforts, the most important was his investigation of the hydrates and other salts of phosphorus. It is true that the interpretation he gave of the results has been materially modified by the modern chemical philosophy, yet the facts which he established form an important part of the basis on which that philosophy rests. Indeed, it seems as if he almost anticipated the later doctrines of types and polybasic acids, and in none of his work did he show more discriminating observation or acute reasoning. A subsequent investigation on the condition of water in several crystalline salts and in the hydrates of sulphuric acid is equally remarkable. Lastly, Graham also made interesting observations on the combination of alcohol with salts, on the process of etherification, on the slow oxidation of phosphorous, and on the spontaneous inflammability of phosphuretted hydrogen. It would not, however, be appropriate in this place to do more than enumerate the subjects of these less important studies; and we have only aimed in this sketch to give a general view of the character of the field which this eminent student of nature chiefly cultivated, and to show how abundant was the harvest of truth which we owe to his faithful toil.

Graham was not a voluminous writer. His scientific papers were all very brief, but comprehensive, and his "Elements of Chemistry" was his only large work. This was an admirable exposition of chemical physics, as well as of pure chemistry, and gave a more philosophical account of the theory of the galvanic battery than had previously appeared. Our late associate was fortunate in receiving during life a generous recognition of the value of his labors. His membership was sought by almost all the chief scientific societies of the world, and he enjoyed to a high degree the confidence and esteem of his associates. Indeed, he was singularly elevated above the petty jealousies and belittling quarrels, which so often mar the beauty of a student's life, while the great loveliness and kindliness of his nature closely endeared him to his friends. He was never married, keeping house with a sister at No. 4 Gordon Square, where he dispensed a liberal hospitality, which has been enjoyed by many of our scientific countrymen who have visited London during the last twenty years.

In concluding, we must not forget to mention that most genial trait of Graham's character, his sympathy with young men, which gave him great influence as a teacher in the College with which he was long associated. There are many now prominent in the scientific world who have found in his encouragement the strongest incentive to perseverance, and in his approval and friendship the best reward of success.

ART. XXI.—*Note on transversely striated muscular fiber among the Gasteropoda;* by W. H. DALL.

IN studying the radula of a species of *Acmæa* (probably *A. Borneënsis* Rve), obtained by Prof. A. S. Bickmore at Amboyna, I noticed, on placing the structure under a power of 100 diameters, that certain of the muscular fibers which adhered to it, when torn from the buccal mass, had a different appearance from the others. On increasing the power to some 800 diameters, it was at once evident that the different aspect of these fasciculi was caused by fine, but clearly defined, transverse striation. Suspecting that it was an optical delusion, caused by a very regular arrangement of the nuclei of the fibres, I subjected the muscle to various tests and to still higher magnifying powers. I also introduced under the same glass, some of the voluntary dorsal muscles of a small crustacean, for comparison. The structure of the ultimate fibers in both appeared to be similar. These seemed to be composed of a homogeneous tube or cylindrical band of translucent matter,

with nuclei interspersed at irregular intervals. In neither was there any appearance of separation into transverse disks, as is seen in the striated muscles of vertebrates. That the striated appearance was not due to contraction and folding of the muscle, was evident upon taking a side view of one of the fibers, when the striæ on each side, as well as the intervening elevations, were seen to correspond exactly to each other.

The only perceptible differences between the muscles of the crustacean and the striated muscles of the mollusk, appeared to be that the latter were much more finely striate; the striæ being six to eight times as numerous as in the former, in the same space. No difference between the striated and non-striated muscles of the *Acmæa* could be observed, except in the fact of the striation. In both the nuclei were irregularly distributed. The appearance of the striated fibre reminded one of a string of rhombic heads, which bore no relation to the position of the true nuclei. The striated fibers appeared, after a careful dissection of the parts in a number of specimens, to be the retractors of the radula; they were longer and in narrower bands than the non-striated fibers and comparatively much fewer in number. The striation was most evident toward the middle of the fibers and became evanescent toward their extremities.

Lebert and Robin (Müller's Arch. f. Anat. and Phys., 1846, p. 126) state that the primitive muscular fasciculi of invertebrates often have the nuclei and intervening clear spaces "arranged in such regular order that they might, at the first glance, be mistaken for transversely striated muscular fibers. The latter, however, are actually found in one acephalous mollusk, *Pecten*, (and probably in *Lima* also), and some annelids," and are constantly present in the voluntary muscles of *Crustacea* and *Insecta*. In the further researches of M. Lebert (Annales Sci. Nat., t. xiii, 1850, p. 161), he observes that there is nothing extraordinary in the discovery of transversely striated muscular fiber in *Polyzoa* (*Eschara*) by Milne Edwards, and in *Actinia* by Erdl, since "the further we have pursued the study of the comparative histology of muscular fiber, the more convinced we have become that transversely striated muscular fiber is to be found in a large number of animals of very inferior organization, without regard to their more or less advanced position in the animal kingdom."

Striated muscular fiber has lately been shown to exist in the "tail" or appendix of *Appendicularia* by Moss (Trans. Lin. Soc., vol. xxvii, p. 300). It was already known to exist in *Salpa*, (Eschricht, ov. Salperne), in the articulated brachiopoda, (Hancock, Tr. Roy. Soc., 1857, p. 805), and in *Pecten*, (Lebert, Annales Sci. Nat. 1850, 3rd ser., t. xiii, p. 166; and Wagner,

Lehrb. d. vergleich. Anat., t. ii, p. 470, 1847), as well as in *Eschara* (Milne Edwards, Annales Sci. Nat., series ii, t. iv, p. 3). I believe, however, that this is the first instance in which it has been shown to exist in the class *Gasteropoda;* and this, as well as the rarity of such cases among the lower invertebrates, is a sufficient apology for bringing forward such an isolated fact. Other duties have not yet permitted me to determine whether this phenomenon is constant throughout the genus, or whether it does or does not occur among allied genera.

ART. XXII.—*Note to Article I, on the Quaternary of the New Haven Region;* by J. D. DANA.

As my statement in regard to the essential independence of the Connecticut valley glacier, and others, in the Glacial era may be misunderstood, I would draw attention to the meaning of the words "under the Continental glacier" in the note to page 2,—in which it is implied that such glaciers are but the inferior portions of the great Continental glacier. I hold that, while the very large valleys of the land, like those of the Connecticut and Hudson, had great influence in determining the direction of the movement in these valleys, especially that along the axis of each, the whole movement must have been more or less modified by the movement of the great northern ice-mass; and that the counteracting influence of a valley depended not only on its depth and extent, but also on its direction and slope. The smaller transverse valleys caused no modification of the general glacier movement; but large transverse valleys gave to the ice in the middle of the channel their own course almost unmodified: if not when the great ice-mass had its maximum thickness, at least afterward when it had become thinner and had lost some of its motion.

I may allude to one other example, as I believe it is, of a partly independent glacier—that of the St. Lawrence valley; for the scratches on its rocks correspond mainly with its course, the prevailing direction, according to Dr. Dawson, being northeast. It should be said that these scratches are attributed by Dr. Dawson to *icebergs* in the Glacial era, which are supposed to have moved southwestward up the valley, the land being profoundly submerged for the purpose, so as to allow of a discharge of the ocean over the continent in that direction; and the fact that boulders were transported *up* the valley is given as evidence in favor of this view. But, as in the case of the

Connecticut valley, icebergs could not have gathered up stones in the bottom of the valley for transportation; and, further, as the era following the Glacial—the Champlain era—was an era without question of submergence to a depth of at least 500 feet along the St. Lawrence valley, there should have been icebergs succeeding to the great St. Lawrence glacier and made from it before its final melting; and such icebergs may well have been driven up the river, then a broad arm of the sea, and thus have distributed southwestward the stones which had been gathered below by the glacier in the Glacial era, besides accomplishing all else that can rightly be attributed to icebergs.

Art. XXIII —*Auroral Belt of October 24th–25th*, 1870.

There was seen at New Haven on Monday and Tuesday evenings, October 24th and 25th last, and at other distant places, in the United States, a belt of deep rose or crimson color from east to west across the southern sky, which possessed very uncommon, if not altogether novel characteristics,—among which the following may be instanced. *First*, its breadth was extreme. The writer estimated it at fifteen degrees, which is fully three times the ordinary breadth. *Second*, both its color and its consistence were wholly unlike anything seen at this place before, so far as is known, pertaining to this particular class of auroral phenomena. The "Aurora's Bow," as this class is called, has always hitherto displayed a yellowish white, like a mildly illuminated strip of cloud, and with a uniform cloud-consistence, although sometimes—very rarely—broken into parallel cross fleeces moving west. In this instance the bow was an assemblage of a few great masses irregularly bounded and illuminated, and in color resembling the ordinary red streamers deepened and darkened in hue. This color prevailed uniformly without intermixture with any other; but the component masses would progressively fade, without disappearing, and again recover brightness. *Third*, this class of arches has ever been noticed to form with suddenness and rapidity, and in motion southward to a stationary position, in which, after from twenty minutes to an hour, the arch would disappear. But in the present instance the bow was permanent, having, as here seen, the same situation, essentially, among the stars throughout Monday evening and night, and the like on Tuesday evening so far as the prevalent mists of that evening would allow observation. In parts of New Jersey, and south of Philadelphia, it appears to have kept nearly one place for forty-eight hours. *Fourth*, these arches hitherto have occupied the position of small circles in the northern hemisphere; but this occupied, here, a great circle, at least from ten o'clock on Monday night to one o'clock on Tuesday morning,—and approximately, the same for two hours earlier in the evening. This position lay centrally in the circle

through or near the stars Alpha Aquilæ, Zeta Aquarii, Eta Ceti and Gamma Eridani; to which last it extended at midnight of Monday and after. At a time during the earlier hours, after nine o'clock and probably at about half past nine, the accurate observer Mr. Willard J. Gibbs, viewing this from an elevated station, concluded that the arch cut the western horizon at or near W. 8° N., and the eastern not farther from the south than S. 28° E. This would consist only with its being, at that time, a small circle in the southern magnetic hemisphere. Its path otherwise and its culmination were not noted by Mr. Gibbs. It deserves mention also that an observer of trustworthy accuracy describes the position in the due southeast, at two minutes before six o'clock, as being at that time nine degrees more south than the then position of the great circle above described would give it. Therefore in comparing mine with any observations made at other places earlier than ten o'clock New Haven time it would be prudent to allow for the culminating point at this place a few degrees of southing compared with the culmination of the circle described,—but not more than three degrees at nine o'clock and six degrees at eight o'clock.

At about this last mentioned time the belt was carefully located by observation made at Burlington, N. J. (115½ miles S. 50° 22′ W. from New Haven), by B. V. Marsh, Esq., who with others observed the phenomena during the evening of Monday, and until half an hour past midnight (Oct. 24th.) From Mr. Marsh's letters to Professor Newton descriptive of the belt I make extracts as follows:— "During all this time—say six hours—a crimson arch (more or less perfect) extended from near the N.E. horizon to near the N.W. horizon varying but little in position. At eight o'clock I noted its position with some care—by the aid of a globe. Its northern edge (which however was *not* sharply defined or very regular) passed about 25° S. of the zenith, and if continued would, I thought, have cut the horizon about N. 45 W. The arch or band was from 10° to 20° wide, perhaps 15° on an average. The color was a very deep crimson (at times) and was especially conspicuous in the N.W. and N.E., although very bright near the meridian also. There was in the north an imperfect and rather faint arch of streamers of a yellowish white color with a dark segment below. Up to half past ten o'clock there was no waving or flashing, but later there was considerable activity that way. Between ten and half past ten the arch seemed to cross the zenith a few degrees farther south than at eight o'clock." In a subsequent letter Mr. Marsh states "the arch [north edge] would have cut the horizon but little if any N. of East. The crimson light reappeared in nearly the same position the next evening."

Referring these statements concerning the north edge of the belt to its central line; it appears that the latter cut the horizon at about W. 30° N. and E. 15 S. and culminated about S. 22° W., having a zenith distance at eight o'clock of 32½°. The culmination at New Haven (lat. 41° 18′) at the same absolute time, was near S. 20 W. and at 44½° in altitude, allowing five degrees and a half southing from the great circle, for the reason just stated, giving a

corrected difference of parallaxes—21° oblique to the meridians—of $10\frac{1}{2}°+$, and concomitant to a difference of bases or chords of $100\frac{1}{4}$ miles:—which bring out a height of 339 miles vertical in lat. 37° 18′·4, or 1° 35′ south of Washington. This would imply that the belt, as seen at Washington, culminated more than 19° south of the zenith. According to the printed account of what was seen at that place — a copy of which in manuscript the writer has received from a trusted correspondent, and has given below—that observed distance was, in fact, but 9°;—however, the tendency to underestimate angular distances near the zenith is so universal that it would not be strange or unexpected to find nineteen degrees of zenith distance described as only nine degrees. This view is confirmed, in the present instance, by the analogous contracted estimate o breadth; which is called but 8°, when, from its nearer proximity to Washington than to Burlington, or to New Haven, it might be expected to subtend an angle of at least 16° or 20°. The account from Washington referred to is the following:—

"October 24—There is a very unusual auroral display to night. The northern sky to the elevation of 30° is brilliant with white light; but a distinct feature consists of a band of blood-red color starting from a point only 8° or 10° N. of W. passing 5° S. of the zenith and touching the horizon again a little S. of East. The breadth of the band is about 8°, and it is very strongly defined throughout."—The probability really is, in accordance with what has been suggested, that, instead of 5°, the north edge passed south of the zenith by as much as 10°, and its middle line nearly as much in addition. The foregoing conclusions are thus substantially confirmed by the observation at Washington; and they make the belt to have been about vertical to Richmond in Virginia,—while it must, equally, have been brilliant not only in central Virginia but through the Carolinas. Investigation will doubtless bring to light the means of a yet more complete and accurate determination of the height and position.

The position of the belt on Tuesday evening, the 25th, is thus described in a letter from W. C. Taylor, Esq., of Philadelphia as seen by him at $9^h\ 35^m$ P. M., at a station seven miles E.S.E. from Philadelphia. "The breadth of the crimson was tolerably uniform, having an average of about 12°. The general direction of the most distinct portion would be indicated by a line through Altair, the trapezium in the Dolphin, and 2° north of the south-eastern star in the square of Pegasus." By this evidence it appears that the belt held a more northern situation at that time than upon the preceding evening. Mr. Marsh informs me that the same was seen to continue, during the evening without "apparent change of position" and until the next morning, by an acquaintance of his—a citizen of Philadelphia—who was traveling from that city to Richmond. He also states that the brilliant crimson light in the northwest had been seen on Monday morning. The same, it appears by the newspapers, was seen also at Cincinnati on that morning in the northeast, "resembling the lights of an immense

fire," and also at St. Louis "illuminating the whole heavens as by a great conflagration."

It only remains to state respecting the aurora of Monday evening, as observed by the writer at New Haven, that by eleven o'clock the faint bank of yellowish white light which, together with a few streamers of a corresponding color, rested low in the north through the hours from six till ten and after, had become suddenly developed into a glowing sheet that covered the entire western, northern, and eastern sky,—everywhere striated and pillared in the western parts with red streamers, and with brilliant white, and pale yellow in the northeast and east. All these had as their base a low yellowish cloud arching over a well defined dark space, whose upper limit, in contact with the bright arch above it, extended about 55° from west of north to east of north, and 7° or 8° high near the north. There were radiations which reached up to a corona having its position in the ordinary relation to the dipping needle's direction, and far north of the great east-and-west crimson belt. The illuminated and extended sheet was pervaded by incessant auroral waves that passed upward with an uncommonly well established and traceable propagation from the cloud arch to the corona, and with an angular velocity estimated to be 1·12° in a second. This great and rare magnificence maintained itself till one hour after midnight, and then, for the time at least, it passed away. A. C. T.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Chlorides of Sulphur.*—Hübner and Guerout have investigated anew the chlorides of sulphur. The chloride S_2Cl_2, corresponding to hydrogen peroxide Θ_2H_2, is easily prepared by saturating sulphur with chlorine and distilling the product. A liquid is thus obtained boiling between 136·5–137°, which gave on analysis 47·63 per cent S and 52·48 per cent Cl, the formula S_2Cl_2 requiring 47·41 S and 52·6 Cl. The chloride thus obtained was then saturated with dry chlorine, the excess being removed by passing dry $C\Theta_2$ through the liquid for three or four hours. A portion of the chloride thus prepared, on oxidation with nitric acid, gave 30·5 per cent S, and 69·3 per cent Cl, the formula SCl_2 requiring 31·07 per cent sulphur and 68·93 per cent chlorine. There are therefore, say these authors, two chlorides of sulphur; a non-volatile chloride Cl_2S, corresponding to water, and decomposed by heat, $(SCl_2)_2 = S_2Cl_2 + Cl_2$; and a volatile chloride S_2Cl_2, obtained from the former, and boiling at 136·5–137°.—*Zeitschr. Chem.*, II, vi, 455, Sept. 1870. G. F. B.

2. *On the soluble and insoluble forms of Sulphur.*—Berthelot has confirmed Lallemand's observation that sulphur, dissolved in carbon disulphide and exposed to sunlight, is converted into the

insoluble variety. But he has also shown that this change may be produced as well by the electric light and by that of burning magnesium, though not by the calcium light. He finds, too, that melted sulphur, fused at 130° and allowed to cool slowly in sunlight, becomes coated with a pellicle of insoluble sulphur; though if cooled in the dark, it remains unchanged. If, however, the solution of sulphur in carbon disulphide be saturated with any body which can cause the inverse conversion, as hydrogen sulphide for example, and the air be carefully excluded, no change takes place on exposure to light. Moreover, in all cases, the sulphur to be converted must first be fused; crystallized octahedral sulphur suffering no change by light. The rays effecting the change are the chemical rays; hence the inactivity of the calcium light.

Berthelot has also examined the thermo-chemical changes resulting from these transformations. For this purpose, it was necessary to determine the quantity of heat evolved or absorbed, 1st, in the solution of the octahedral sulphur; 2d, in the fusion of this sulphur; and 3d, in the conversion of this variety into the insoluble form. The first of these determinations was not difficult; one gram of sulphur, in dissolving in carbon disulphide, absorbs 12·8 calories. The second datum was derived from the observations of Person which show that, in fusing, one gram of octahedral sulphur absorbs 9·4 calories. The third determination was more difficult; the inverse change of insoluble to ordinary sulphur takes place at 112°, and is accompanied by an evolution of heat; but this cannot be applied to the changes at common temperatures. Insoluble sulphur may be converted in the cold, by placing it in contact with a solution of hydrogen sulphide. This action, which alone is too slow for the purpose, may be completed in from 30 to 40 minutes, by adding to the solution of hydrogen sulphide a tenth of its volume of alcohol, no other chemical change being produced. This transformation thus modified, was effected in a calorimeter. As a mean, it appeared that at 18·5°, one gram of insoluble sulphur evolves on conversion, 2·7 calories. Upon dissolving the converted sulphur in $\mathrm{CS_2}$, however, Berthelot found for each gram an absorption of 15·4 calories, nearly one-fourth more than that absorbed by the solution of the octahedral variety. From which he concludes that the freshly converted sulphur is a distinct variety, and gives it the name of *soluble amorphous sulphur*. Under the microscope, it appears in utricular masses like the insoluble sulphur; but in the course of a few hours, crystalline points appear on these masses, and the whole becomes crystalline in a few weeks. A new determination gave an absorption of 13·1 calories for each gram of sulphur; showing that now the amorphous was converted into the crystalline sulphur. Moreover, the amorphous sulphur, when dissolved in $\mathrm{CS_2}$ can be obtained again only as octahedral sulphur. Since, then, the change of the soluble amorphous sulphur into octahedral sulphur is attended with an *absorption* of 2·6 calories, and the change from the insoluble variety into the amorphous soluble form, is attended with an *evolution* of 2·7

calories, sensibly the same quantity, it follows that no change of temperature accompanies the conversion of insoluble into octahedral sulphur.

From the data thus obtained, proving that, both in solution and when melted, an evolution of heat accompanies the conversion of ordinary octahedral sulphur into the insoluble variety, under the influence of light, Berthelot concludes that in these changes, the light does not effect the work of the transformation, but is simply the exciting agent.—*Bull. Soc. Ch.*, II, xiv, 106, Aug., 1870.

G. F. B.

3. *On the remarkable changes of color produced in certain iodides by heat.*—In some experiments upon the preparation of double iodides, MEUSEL found that on adding a solution of silver nitrate to one of mercuric iodide in potassium iodide, a bright lemon-yellow precipitate was thrown down, which, on slightly warming the solution, became intensely orange-red, but regained its yellow color on cooling. Further experiments showed that the same property was possessed by mercuric-cuprous iodide. If to a warm solution of mercuric iodide in potassium iodide, copper sulphate and then sulphurous acid be added, a brilliant carmine-red precipitate is obtained which becomes intensely black on heating to 70°. At first, these bodies were considered to be definite double iodides; but Meusel, finding that they may be prepared by mixing together the separate iodides under water, and that the precipitated substances may be partially separated mechanically, concludes that they are mixtures, and accounts for the change of color by a variation in the absorptive power for light of the silver and the cuprous iodides respectively at different temperatures.

WILLM and CAVENTOU, on the other hand, maintain that these precipitates are true double iodides. The cuprous mercuro-iodide, they assert, gives up nothing to a cold solution of KI, has the definite formula $Hg(Cu_2)I_4$, and yields two definite crystalline products when treated with ammonia.

BOETTGER suggests moistening these powders with a little weak gum-water and drawing devices with them on paper. The change of color by heat is then easily shown as a striking lecture-experiment.—*Ber. Berl. Chem. Ges.*, iii, 123, 1870. *Bull. Soc. Ch.*, II, xiii, 220, 1870. *J. pr. Ch.*, II, ii, 136, Aug. 1870. G. F. B.

4. *On Tetramethylformene.*—Three isomeric hydrocarbons belonging to the marsh-gas series, C_nH_{2n+2} and containing five atoms of carbon, C_5H_{12}, are theoretically possible:

1. $C\begin{cases} CH_2CH_3 \\ H \\ H \\ CH_2CH_3 \end{cases}$ 2. $C\begin{cases} CH_3 \\ CH_3 \\ H \\ CH_2CH_3 \end{cases}$ 3. $C\begin{cases} CH_3 \\ CH_3 \\ CH_3 \\ CH_3 \end{cases}$

Of these only the second, prepared from amyl alcohol, has, until recently, been obtained. Lwow, under the direction of Professor Butlerow, has succeeded in forming the third, by acting upon tertiary butyl iodide with zinc methyl, according to the equation:

$$(C(CH_3)_3I)_2+Zn(CH_3)_2=(C(CH_3)_4)_2+ZnI_2.$$

The zinc methyl was added by drops to the butyl iodide, and the evolved gas washed with dilute HCl, and collected in well-cooled alcohol. On diluting the saturated alcohol solution with water, the new hydrocarbon was evolved as a gas, which, conducted into a well-cooled receiver, condensed to a liquid. This was freed from other hydrocarbons by treatment, first with bromine and then with sodium. Fifty grams of tertiary butyl iodide and 13 grams zinc methyl, gave 15 grams of pure C_5H_{12}, almost the theoretical quantity. The hydrocarbon thus obtained is a colorless, mobile liquid, boiling at 9·5°, and solidifying at −20° in crystals, resembling sublimed sal-ammoniac. This remarkable solidification by cold, is characteristic of all highly methylized compounds, as trimethylcarbinol, methyl oxalate, tetramethylbenzol or durol, etc. Analysis established the formula C_5H_{12}; a determination of the vapor-density by Hofmann's method, gave 2·495, the calculated density being 2·493. This hydrocarbon, it will be seen, is marsh-gas, in which all four atoms of hydrogen are replaced by methyl. Berthelot's name for marsh-gas being formene, this body has received the name tetramethylformene. It is distinguished from isoamyl hydride by the facility with which it crystallizes. —*Zeitschr. Chem.*, II, vi, 520, Nov. 1870. G. F. B.

5. *On an aromatic glycol.*—Although Wurtz prepared the first glycol, or diatomic alcohol of the fatty series in 1856, yet no similar body belonging to the aromatic series has, until now, been obtained. Such a body Grimaux has recently succeeded in producing. Starting with the fact that xylol, C_8H_{10}, may be viewed as di-methyl benzol $C_6H_4 \begin{cases} CH_3 \\ CH_3 \end{cases}$, Grimaux treated it at a boiling heat, with chlorine expecting to obtain either a chloride analogous to ethylidene chloride and corresponding to an aldehyde, $C_6H_4 \begin{cases} CHCl_2 \\ CH_3 \end{cases}$, or one analogous to ethylene chloride, and corresponding to the hydrochloric ether of a glycol, $C_6H_4 \begin{cases} CH_2Cl \\ CH_2Cl \end{cases}$. The chloride in question was first prepared in 1867, by acting with chlorine upon xylol obtained from coal-tar, heated to 140°. The yield was very small, however; a fact since accounted for by Fittig's discovery that the xylol from coal-tar is a mixture of 90 per cent isoxylol, and 10 per cent methyl-toluol, from the latter of which alone the above chloride is formed. Investigation having proved that the chloride thus obtained was the second of those given above, Grimaux proposes the name *tollylene* for its radical C_8H_8, or $\left(C_6H_4 \begin{cases} CH_2 \\ CH_2 \end{cases}\right)''$. The body $C_6H_4 \begin{cases} CH_2Cl \\ CH_2Cl \end{cases}$ is therefore tollylene chloride. By solution in chloroform and crystallization, it is obtained in the form of hard, transparent, rhomboidal prisms, fusing at 100° and distilling above 230°. Heated with water, it yields tollylene glycol; treated with alcoholic solutions of sodium acetate or benzoate, it forms tollylene diacetate or monobenzoate. It yields terephthalic acid by oxidation with potassium dichromate and sulphuric acid. The tollylene glycol,

$C_6H_4\begin{cases}CH_2OH\\CH_2OH\end{cases}$, was obtained from the chloride, as above, by heating it in a close vessel to 170–180° with thirty times its weight of water. The saponification was complete at the end of two hours, and by evaporating the water the glycol crystallized in needles, which, after purification, were found to fuse at 112–113°, to be very soluble in water, alcohol, and ether, and to yield terephthalic acid by oxidation. The analogy of these two bodies to ethylene glycol and its corresponding acid, Grimaux shows by writing them as follows:

$\begin{cases}CH_2OH\\CH_2OH\end{cases}$ Ethylene glycol. $\quad\begin{cases}COOH\\COOH\end{cases}$ Oxalic acid. $\quad C_6H_4\begin{cases}CH_2OH\\CH_2OH\end{cases}$ Tollylene glycol. $\quad C_6H_4\begin{cases}COOH\\COOH\end{cases}$ Terephthalic acid.

—*Bull. Soc. Ch.*, II, xiv, 133, Aug. 1870. G. F. B.

6. *On the production of solid cresol.*—Wurtz proposed some time ago, a method for converting the aromatic hydrocarbons into phenols. This consisted in treating the hydrocarbons with sulphuric acid, and then decomposing the sulpho-acids thus obtained, by potassium hydrate in excess. In a recent experiment, 300 grams of toluol were converted into cresyl-sulphurous acid, and the potassium cresyl-sulphite fused in a silver basin with a mixture of potassium and sodium hydrates. This fused product, on treatment with hydrochloric acid, yielded 200 grams of crude cresol, boiling above 190°, the larger part at 198° to 204°. On cooling these latter products, a solid mass was deposited, which, after washing with ether, had a brilliant white, lustrous appearance and a strong odor of phenol. It melted at 34·5° and boiled at 201·5 to 202°.—*Bull. Soc. Ch.*, II, xiv, 6, July, 1870. G. F. B.

7. *On the synthesis of aromatic acids.*—Erlenmeyer and Gütschow having shown that sodium formate, when heated alone, is broken up into hydrogen and sodium oxalate, Victor Meyer concluded that at a certain instant of this change, both hydrogen and the carboxyl group $(COONa)'$ existed in the nascent state; and therefore, that if sodium formate were fused with the potassium salt of an aromatic sulpho-acid, its hydrogen would combine with the group $(SO_3K)'$, while its carboxyl group would replace it, according to the equation:—

$$RSO_3K+H(COONa)=HKSO_3+R(COONa).$$

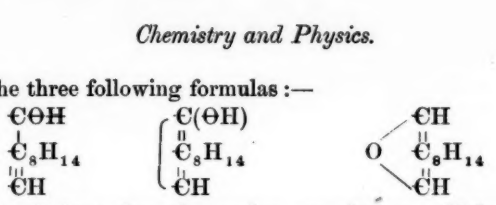
Equal quantities of dry sodium formate and potassium phenyl-sulphite were intimately mixed and fused for several minutes, with constant stirring, in a porcelain dish. The brown mass was dissolved in water, acidulated, and distilled, the distillate made alkaline with soda, boiled with animal charcoal to free it from sulphur compounds, concentrated by evaporation, and treated with hydrochloric acid. A copious precipitate of benzoic acid was thrown down, which by recrystallization and sublimation, was obtained pure. In another experiment, equal parts of sodium formate and potassium sulphobenzoate were intimately mixed together and then fused. The reaction took place more easily and uniformly than in the former case, and at a lower tempera-

ture. On dissolving the mass in water and acidulating the solution, ether extracted an acid from it which was proved to be isophthalic acid.—*Ber. Berl. Chem. Ges.*, iii, 112, Feb., 1870.

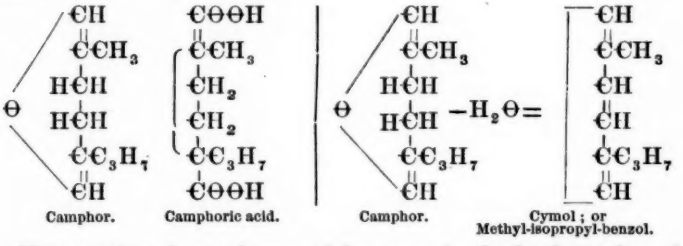
G. F. B.

8. *On the constitution of Camphor.*—Victor Meyer has also investigated the constitution of common camphor, which, though the substance has long been known and has been chemically examined repeatedly, has never yet been satisfactorily determined. Of its reactions, the two most important are the production of cymol when acted on by substances capable of withdrawing water from it, and the almost unique production of a dibasic acid by the direct union with it of three atoms of oxygen. The hope of getting some light on this question from the production of phorone alike from calcium camphorate and from acetone, is destroyed by Baeyer's observation that these two phorones are isomeric and not identical. Meyer begins therefore, with the study of camphoric acid. This acid is dibasic; but it possibly does not contain two carboxyl groups, being perhaps an oxy-ketonic acid, containing one carboxyl group, together with the grouping $\begin{matrix}\text{C}\Theta\\ \text{CH(OH)}\end{matrix}$, as Weyl has suggested. To test this question, camphoric acid was distilled with soda-lime, in the expectation, that, were two carboxyl groups present, $(\text{C}\Theta_2)_2$ would be removed, leaving the hydrocarbon C_8H_{16}. Owing, however, to the low temperature at which camphoric acid breaks up into the volatile anhydride and water, no hydrocarbon was obtained. The observation of Moitessier, however, that copper camphorate yields on dry distillation $(\text{C}\Theta_2)_2$ and a hydrocarbon C_8H_{14}, was confirmed; a fact which Meyer regards as making probable the existence of two carboxyl groups. To test Weyl's view positively, the fact that all known ketonic acids are reduced to oxyacids by nascent hydrogen was made use of, and camphoric acid was treated with sodium amalgam for a week; but without change. Lastly, it was proved that no third hydroxyl group was contained in this acid, by heating ethyl camphorate $\text{C}_{10}\text{H}_{14}\Theta_4(\text{C}_2\text{H}_5)_2$ with excess of acetyl chloride in a sealed tube for several days; no change was observed in the ether. From these facts, Meyer gives the formula of camphoric acid as $\text{C}_8\text{H}_{14}\left\{\begin{matrix}\text{C}\Theta\Theta\text{H}\\ \text{C}\Theta\Theta\text{H}\end{matrix}\right.$. Remembering now the second fact above given, that camphor, by loss of water, gives cymol, a homologue of benzol, it is probable that six of its carbon atoms form a main chain, the other four being in the form of lateral chains. Moreover, two of the carbon atoms in the main chain must take up oxygen in its oxidation, else there would be a separation of hydrogen as water; and lastly, the production of cymol shows that the carbon atoms yielding the two carboxyl groups are not united to the same carbon atom. Writing therefore, the formula of camphoric acid $\left\{\begin{matrix}\text{C}\Theta\Theta\text{H}\\ \text{C}_8\text{H}_{14}\\ \text{C}\Theta\Theta\text{H}\end{matrix}\right.$, camphor itself may have

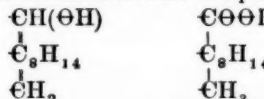
one of the three following formulas:—



The first of these formulas makes camphor an aldehyde. But this view, though proposed long ago by Berthelot, cannot be held since Tollens and Fittig showed that camphor possessed none of the characteristic properties of an aldehyde. According to the second formula, camphor contains a hydroxyl group and is a kind of alcohol. This is rendered improbable by Berthelot's experiments, who found that while borneol, which is an alcohol, formed an ether with acid hydrates, camphor was entirely indifferent to them. Moreover, Meyer treated camphor with acetyl chloride, with glacial acetic acid, and, in alcoholic solution, with hydrochloric acid gas, without changing it in the least. Hence, camphor contains no hydroxyl group. The third formula therefore is the only one possible. The constitution of the nucleus C_8H_{14} is to be interpreted from that of the camphor-cymol, which, as Fittig, Köbrig and Jilke have shown, is either diethylbenzol or methyl-propyl (or isopropyl) benzol. Adopting the latter view, we have for the rational constitution of camphor and camphoric acid, the following formulas:



The reaction above given explains very simply the formation of cymol; by loss of water, the hydrogen-atoms of the third and fourth carbon atoms take out the oxygen, thus doubly uniting these carbon atoms and combining the end carbon atoms into the closed chain characteristic of the aromatic series. Moreover, in the camphor formula the carbon chain is not closed. Hence, the lateral chains remain intact during oxidation; while in true aromatic compounds, which contain closed chains, the lateral chains are always the ones oxidized. The following formulas are given by Meyer for borneol and for campholic acid.



—*Ber. Berl. Chem. Ges.*, iii, 116, Feb. 1870. G. F. B.

9. *A Text-book of Elementary Chemistry, Theoretical and Inorganic;* by GEO. F. BARKER, M.D. — Prof. Barker's excellent treatise has already been briefly noticed in this Journal, and we propose now to call attention somewhat more in detail to its advantages and merits as an elementary work. The first 86 pages are devoted to Theoretical Chemistry, which is here made to include stœchiometry, nomenclature and the general theory of combination. The remainder of the work is occupied with descriptive inorganic chemistry. Each chapter terminates with a series of questions always valuable but particularly useful in making the student thoroughly acquainted with the introductory or theoretical portion of the work, which is wholly in the spirit of the most advanced thought in the science. To the author's nomenclature we take some exceptions. Such terms as *potassium chlorate*, *calcium phosphate*, &c., though employed by many English chemists at the present day, are, to say the least, of doubtful etymological propriety, and we greatly prefer the corresponding adjective forms, *potassic chlorate*, *calcic phosphate*, &c., while admitting that these are not always of easy application. Dr. Barker himself occasionally employs the adjective forms, and will, we hope, carry them out systematically in future editions. On the other hand, however, we heartily agree with him in rejecting the absurd term "anhydride," which denotes, not what a substance does but what it does not, contain, and in employing such names as sulphurous and sulphuric oxide for $S\Theta_2$ and $S\Theta_3$, nitrous and nitric oxide for $N_2\Theta_3$ and $N_2\Theta_5$, &c., adopting the form *carbonic dioxide* for $C\Theta_2$ to avoid confusion. With the author's original views as to the constitution and nomenclature of the ortho-acids and bases and their derivatives, we also entirely agree. The descriptive part of the work is carefully and judiciously compiled, omitting unnecessary and burdensome detail. Upon the whole we find in Dr. Barker's work a concise, logical and clear treatise, well adapted as a first book, and we sincerely hope that it may be followed by a similar work on Organic Chemistry. W. G.

II. GEOLOGY AND NATURAL HISTORY.

1. *A Reply to Mr. Dall's criticism on the Brachiopods as a division of the Annelids;* by EDWARD S. MORSE. — The July number of this Journal contained a brief abstract of a verbal communication made by me before the Boston Society of Natural History, on the "Brachiopoda as a division of the Annelida."* I did not expect the concurrence of conchologists to the view there advanced, for I recalled the manner in which an eminent conchologist of England, Mr. Sowerby, received the announcement by Thomson that the Cirripeds were Crustaceans. So in this question, the Conchologists, so far as I am aware, oppose it. While any impartial review would have been answered in my

* Since republished from this Journal in the Annals and Mag. Nat. History, London.

memoir now in preparation, it seems proper that a reply should be made to a criticism contained in "a Revision of the Terebratulidæ and Lingulidæ, etc.," by Wm. H. Dall, and published in the American Journal of Conchology, vol. vi, part 2. While thanking Mr. Dall for his kindly notice of my labors, and appreciating fully the value of the work he is engaged in, as comprised in his communications to the above named Journal, I am yet compelled to plainly criticize the manner in which he has presented the question in his review.

Mr. Dall says that the "utmost impartiality" should be used in the discussion and "due consideration should be given to the facts," etc. This "utmost impartiality" is illustrated, by passing over in absolute silence, not only all my references to the limited knowledge we possess of the embryology of the Brachiopods as shown by Lacaze Duthiers, but the dorsal and ventral plates—the serial arrangement above and below of setæ, and even the gill laminæ in *Lingula*, as first recognized by Savigny in the annelids—the bi-lobed lophophore—the cephalic collar—the thin and muscular visceral walls—the singular results obtained by Gratiolet in the chemical analysis of the shell of *Lingula anatina*—the presence of the cæcal prolongations of the mantle, and their relations to the *porenkanale* in the annelids—and, above all, the remarkable existence of one or more pairs of *segmental organs*, in form, character and functions like the segmental organs of the annelids, the first feature that led me to regard the Brachiopods as annelids six months before I ever saw living *Linguloe*. All these points are passed over in the "utmost impartiality" of silence. Overlooking with the same impartiality my statement that the Brachiopods presented a *comprehensive type*, and comprised certain crustacean characters, he neglects to mention the winter egg of the Polyzoa and similar features in the lower Crustacea, and we might add similar features in certain rotifers now admitted to be worms. So also the presence of striated muscular fiber in certain muscles of the Brachiopoda, their absence in the Mollusca, and their presence as one of the prominent characters in Crustacea. He gives us, however, Clark's definition of the Mollusca which comprise the characters of the branch as then understood, which includes of course the Tunicata, Polyzoa and Brachiopoda. In defining the Vermes, with the same impartiality, reference is made only to those Vermes in which the body is made up of a repetition of similar parts, overlooking entirely the unisegmental Vermes which comprise a large proportion of the class; nor is reference made to the remarkable cephalization of many Annelids, where the posterior portion of the body has been called a caudal appendage, being without bristles. In some, the thoracic rings, few in number, have a wide flaring membrane running continuously along each side (*Protula.*)

We leave others to judge of his conclusions respecting the character of the setæ, as also his startling homology of the peduncle of *Lingula*, and the syphonal tubes of a clam (!) and call attention to his statement, that because the setæ are not found the

entire length of the peduncle, therefore they are by no means "identical" with those of the worms. This will be a new idea to naturalists, that the confinement of appendages to limited portions of the body, forbids all homology with those in which the appendages run the entire length. It indicates also that Mr. Dall believes that all Chætopods have setæ from head to tail.

He states as a grave objection that the Brachiopods are invariably attached by muscles to a bivalve shell. In the same breath he should have added that worms are also invariably attached to a *bivalve* or multivalve shell, whether it be the scuta of *Sternaspis*, the oval plates of *Lepidonotus*, or the hardened integuments of others.

He lays great stress on the presence of bristles in Chiton, as if that group were the very embodiment of the Molluscan type, but with the same impartiality he neglects to mention its embryology, so remarkably articulate as shown by Lovén, its dorsal vessel, the double and forward opening of the oviducts, the anus terminal, and other features so remarkably articulate, as to induce De Blainville to recognize their affinities with the annelids, to prompt Milne-Edwards to call them a Satellite group, and to cause Jeffries to liken them, in their different stages, to "Isopods, tiny trilobites, Onisci and Aphrodita."

In mentioning my anatomical drawing of various Brachiopods, he says, "some of them taken from life," he should have said, "most of them taken from life."

In concluding his paper he refers to drawings in my collection of a "singular sipunculoid worm," "and appears from them, to have an anterior termination to the intestine, thus forming a notable exception to the general rule among worms." The drawing to which he refers is the common sipunculoid worm of the coast. *Phascolosoma*, *Sipunculus* and its allies claim it as a right to have an anterior termination to the intestine, a fact known to every one who ever made them a study. Finally, in his comparisons, with the exception of Chiton, he confines himself to, and only points out a few of the many relationships between the Brachiopods and Polyzoa and Tunicates, admitted by all. Now since Leuckart, Gegenbaur, Haeckel, and other eminent naturalists of Europe, have seen conclusive reasons to remove the Polyzoa and Tunicates entirely from the Mollusca, and place them among the Vermes, it seems that Mr. Dall's first task should be to whip these back to the Mollusca, before commencing with the Brachiopods.

2. *On Eozoon Canadense;* by Prof. Wm. King, S.C.D., and Thos. H. Rowney, Ph.D., of the Queen's Univ. in Ireland, and the Queen's College, Galway. 42 pp. 8vo, with three colored plates, (Proc. Roy. Irish Acad., July, 12, 1869).—The following Supplementary note to the paper noticed on page 68, was read Feb., 1870.

Within the last fortnight we have been successful in finding "eozoonal" structures under conditions which unmistakably establish their origin.

We have first to notice a specimen of ordinary metamorphic micro-crystalline limestone, from Aker, in Sweden. It contains numerous light green grains of pyroxene of the variety known as coccolite, a considerable portion of a colorless translucent variety of a related mineral seemingly malacolite, and a few small purple spinels. The grains of coccolite, which have a rude cleavage approximating to a sub-conchoidal fracture, are isolated, or form aggregations, in the calcareous matrix: their surfaces are variously rounded and excavated, giving the grains an irregularly lobulated appearance. The occasional presence of planes, edges, and solid angles on their surfaces, renders it certain that the grains were originally crystals that have undergone superficial erosion by some dissolving agent. The spinels, which are in octahedrons, have been subject to a similar waste, though not to the same extent—only occasionally occurring more or less spherical, and with eroded surfaces.

In their irregular lobulated character, variety of aggregation, and scattered arrangement, the grains of coccolite strikingly resemble those of serpentine ("chamber casts") in the "acervuline" variety of "*Eozoon Canadense*," occurring in Canada. We take credit for being the first to point out a precisely similar agreement in the grains of chondrodite, pargasite, &c., common in the crystalline limestones of other places.*

But the specimen under notice shows other and additional characters, which still more clearly establish its "eozoonal" relationships.

When a slight portion of the matrix is removed by decalcification, the surface is seen to be crowded with slender cylindrical forms, more or less branching, often remarkably beaded, and arranged in all conceivable modes of grouping. They agree in every respect with the finest typical examples of the "canal system," as represented by Doctors Carpenter, Dawson, and Professor Rupert Jones.†

Associated with the latter are numerous specimens of the malacolite, divided by different sets of cleavage planes, the principal one giving them quite a lamellar structure. Occasionally others occur approximating more or less to perfect prismatic crystals: but generally some of the angles, edges, and planes, have disappeared, or only traces are observable; so that they present the appearance of vermicular rods—straight, bent, or twisted—nodulose, or irregularly excavated. These configurations exactly answer to certain of the so-called "stolons."‡

It may be contended, by those from whom we differ on the question discussed in these pages, that the specimen belongs to an "eozoonal" rock. But, apart from its fatal agreement with other

* "Quarterly Journal of Geological Society," vol. xxii, p. 209.

† See Dawson in "Quarterly Journal of Geological Society," vol. xxi, Pl. VII, figs. 3, 4, 5; Carpenter, ibid, Pl. VIII, fig. 5, *a*, *b*, *c*, and Pl. IX. fig. 5, *a*, *b*, *c*, *d*; Rupert Jones, "Popular Science Review," vol. iv, Pl. XV, figs. 6, 7, 8.

‡ See Carpenter, "Quarterly Journal of Geological Society," vol. xxi, Pl. VIII, fig. 3, Pl. IX, fig. 3; Jones, "Popular Science Review," vol. iv, Pl. XV, fig. 5.

specimens of the kind in possessing the never-failing crystalline or metamorphic character—how, on such a view, are we to set aside the clear evidences of the "chamber casts" and the "stolons" having been originally crystals?

Besides, not only have these parts had a crystalline origin, but it is equally plain that the same conclusion must embrace the "canal system;" for it is impossible to detect any line of demarcation between the "stolons" and the latter. Dissolving action has, in the first place, converted the crystals of malacolite into the "stolons:" next the crystals were divided by cleavage, and eroded to such an extent that, in the state of the "canal system," they became reduced to mere skeletons.* Respecting the beaded character of the branching forms, we are strongly inclined to believe that it has resulted from the cleavage which transversely cuts the prisms: obviously the erosion would be deepest where it was present.

In no instance have we detected any traces of the "nummuline layer" on the grains—a deficiency we attribute to their component mineral, coccolite, not assuming the fine asbestiform structure which so eminently distinguishes serpentine in its change into chrysotile. There is often, however, a thin whitish granular coat investing the grains, sometimes so compact as to remain after they have been accidentally detached from the matrix.

Another specimen, which is from Amity, New York, consists of a similar calcareous matrix, holding spinel, chondrodite, serpentine, a micaceous mineral, and malacolite. One of the crystals of spinel is a compound octahedron, about two inches in its axial diameters, having part of its faces built up of minute triangular facets, and others, of small implanted octahedrons; both lying parallel to the faces of the large crystal. Numerous linear chinks, and irregularly formed cavities, separate the component triangular facets and octahedrons; and they are filled up with micro-crystalline calcite, similar to that of the matrix, enclosing malacolite. Decalcification brings out beautifully the last-named mineral, which assumes with wonderful exactness all the characters and modifications of the "stolons" and "canal system," as displayed in the Aker specimen; so that the description we have given of them would have to be repeated if we described those under consideration: and were it necessary to represent the latter, our representations would be close *fac-similes* of the figures, already referred to, which Dawson, Carpenter, and Rupert Jones, have published in their respective memoirs.

All the calcite of the specimen equally shows the same "eozoonal" structures; and that they have originated from the waste of crystals of malacolite. One example consists of a prismatic or

* It may be hypothetically suggested that, in the final stage, the crystals have been totally dissolved. Malacolite consists, in round numbers, of silica 55, lime 23, magnesia 17. Assuming carbonic acid to have acted as the solvent, this substance might completely replace the silicic acid, and in this way change the basic constituent of the mineral; making calcite (or dolomite) a pseudomorph after malacolite.

longitudinally-cleaved mass of this mineral, having at one end the cleavage prisms diverging, losing their edges, and slightly branching; strikingly resembling the case figured in our first memoir,* and reminding us of the example of the "canal system," described by Dr. Carpenter as "consisting of parallel lamellæ disposed like the leaves of a book."†

Since it was first announced that we had determined "*Eozoon canadense*" to be nothing more than a mineral production, we have all along felt that specimens would be found demonstrating more and more completely the truth of our conclusion: but we were certainly not prepared to meet with a large crystal of spinel, holding in its chinks and cavities typical examples of two of the essential features of this reputed organism: and these themselves possessing evidences indisputably testifying to their purely crystalline origin.

The Aker and Amity specimens show, what we have long suspected, as intimated here and there in the preceding paper, that the arborescent forms ("canal system") may consist of other silicates besides serpentine. As to their being composed of anything else than a siliceous substance, we are not yet prepared to offer an opinion on the matter; though it must not be overlooked that similar forms, but on a comparatively gigantic scale, are common, consisting of carbonate of lime, in magnesian limestone, near Sunderland, in Durham. We have been led into this subject from observing a recent announcement, by Dr. Sterry Hunt, of *another* discovery in "*Eozoon canadense*" (at Chelmsford, near Lowell, U. S.) of "the canals and tubuli of the calcareous skeleton filled, not with a silicate, but with carbonate of lime."‡ On seeing this announcement, we immediately wrote to Mr. Bicknell, of Salem, mentioned by Dr. Sterry Hunt, asking him to oblige us with specimens of the kind. Shortly afterwards we received from Mr. Bicknell, by sample post, a transparent section carefully prepared by himself, and a piece of the rock,—both labelled "Chelmsford." There were also specimens of "eozoonal" ophite from Newberryport, a neighboring locality. In the latter, some of the structures are typically exhibited: the fibers of the "nummuline layer," however, are more confusedly arranged, and much longer than usual. In the former, the serpentine, of a pale-greenish color, is in irregularly fractured pieces, separated from one another by unusually wide interspaces of calcite ("calcareous skeleton,") which contains bundles of radiating crystals, also groups of vermicular branching forms ("canals and tubuli"): the "nummuline layer" is not well developed, being often represented by minute radiating aciculi. We have carefully tested the Chelmsford specimens, both by chemical reactions and polarized light, without however, detecting any evidence of the "canal system" being else than siliceous; or of being composed of a substance identical with or related to its

* "Quarterly Journal of Geological Society," vol. xxii, Pl XV, fig. 17, *b*.
† "Intellectual Observer," vol. vii, p. 294.
‡ "Scientific Opinion," January 20, 1870, p. 45.

calcareous matrix.* Now, we cannot dispute the statement of Dr. Sterry Hunt; as probably some mistake may have been made in our specimens. We must, however, *in this case too*, complain of the very meagre and unsatisfactory account given of the "canals and tubuli" in the otherwise more detailed notice of the Chelmsford "Eozoon," published in the Am. Journ. of Sci., p. 77, of January last. No evidence whatever is offered to show by what process the chemical nature of these parts was determined;—whether the conclusion that they are of the same composition as the "calcareous skeleton" was based on an examination by polarized light; or whether they do not consist of some soluble silica, or of a mixture of a carbonate and a silicate such as would be quite as readily acted upon by weak acid as their imbedding substance, especially if it be dolomite. We wish to call particular attention to the last point, as brief mention has already been made of a specimen of elæolite (a translucent variety, from Brevig), which, in consequence of its being an alkaliferous silicate of alumina (and there is no reason why such a compound may not occur in the Laurentian metamorphic marbles), was dissolved in weak acid. Another specimen, which we have lately subjected to the same process, was taken out of the solution in a partially digested state. When examined with the microscope, the residuum, which is in a slightly coherent condition, was found to consist of interlacing configurations, some of which, where well separated from the rest, bore no inconsiderable resemblance to the "canal system"—not, it is true, in its beautiful arborescent forms, but in the small crooked branching varieties, common to many Canadian examples. Prismatic cleavage, which elæolite eminently possesses, had evidently favored the development of the configurations. They are transparent, rudely branching and anastomosing, showing rarely any cleavage edges or planes; these for the most part having been emoved by the action of the acid.

Such a case as this clearly necessitates every point being duly considered before any conclusion can be drawn as to the chemical nature of the "canals and tubuli," should they appear not to have their ordinary composition. It also strikingly illustrates the view we have taken that these parts in typical "*Eozoon*" are merely the skeletons of fragments, or of crystals—respectively of serpentine or some other silicate—which remain after their waste had been arrested through changed conditions. Moreover, it testifies to our having succeeded in forming from elæolite, by the action of a weak solvent, configurations approximating to the rude varieties of the "canal system."

3. *Scientific Expedition to the Rocky Mountains.*—The Yale College scientific party, in charge of Professor O. C. Marsh, which left New Haven in June last for the Rocky Mountains, returned to this city on the 18th of December. The party, which was essentially a private one, consisted of Professor Marsh and twelve com-

* We expect still to receive specimens, undoubtedly identical with those described by Dr. Sterry Hunt; when we hope to announce with more certainty the result of our investigations.

panions, all students or recent graduates of the College. The main object of the Expedition was to investigate the extinct vertebrate fauna of the Tertiary and Cretaceous deposits of the Rocky Mountain country, and the general plan adopted was to make several separate trips, of one or two hundred miles north or south of the Pacific railroad, to regions that were unexplored, or had never been carefully examined.

The first of these was made early in July, from Fort McPherson in Nebraska, to explore the Pliocene deposits along the Loup Fork river. Here rich collections of fossil vertebrates were obtained, and several new species of extinct mammals and birds discovered. The next expedition was made in August, from Fort D. A. Russell in Wyoming, to examine the geology of the country between the North and South branches of the Platte river. On this trip the Mauvaises Terres or "Bad land" formation, with the true *Titanotherium* and *Oreodon* beds was discovered in Colorado,* and traced northward through Nebraska to the North Platte. The fossil remains obtained were also important, and included several species of extinct mammals and birds, new to science.

The third expedition was made from Fort Bridger, Wyoming, in September and October, to examine the geology of the Eastern Uintah Mountains, and the country between the Green and White rivers. In this region interesting geological discoveries were made, and many new Tertiary vertebrate remains secured, which will soon be described by Professor Marsh. On their return, the party went to California, and spent a month in visiting various points of scientific interest; after which they came east to Denver, and thence to Fort Wallace in Kansas. About two weeks were spent in exploring the Cretaceous beds of this vicinity, where some interesting reptilian and fish remains were obtained, and the party then returned to the east.

The Expedition as a whole was very successful, and the large collections made will be placed in the Peabody Museum of Yale College. The more important scientific results will soon be published.

4. *Monograph of the North American Astacidæ;* by Dr. H. A. Hagen. No. III of the Illustrated Catalogue of the Museum of Comparative Zoölogy. Cambridge, 1870.—Our American crawfish have been much neglected, never having been subjected to thorough study, and, as might be expected, Dr. Hagen has given us an accurate and very valuable monograph. The investigation of the constancy of the specific characters and the sexual peculiarities are highly interesting and form the most important feature of the work. In *Cambarus*, which includes all the species east of the Rocky Mts., the author has found that the first abdominal legs of the male present great and very constant specific differences, similar to those discovered in *Callinectes* by Ordway, and to those in some species of *Achelous* and *Cardiosoma*. In this same genus two forms of males are described,—ordinary fully developed in-

* This Journal, II, vol. l, p. 292, Sept., 1870.

dividuals, and a second form in which the individuals retain many of the features of the young and are supposed to be sterile. While the second form of males was found in every species of *Cambarus* of which any number of specimens were examined, it was found in none of the species of *Astacus*. This important discovery of dimorphism in the males of *Cambarus* is accredited to Prof. Agassiz. It is mentioned that perhaps the "fact of the existence in the Crustacea of two forms, one always sterile, is not unique," and a short account of dimorphism in other Crustacea and in insects is given. Among the decapods, the author notices the occurrence of sterile females in "*Lupa* and *Callinectes*," and states that he has "found similar females with a narrower triangular abdomen in some other genera of *Brachyura*." The occurrence of dimorphic sterile females is much more common among the *Brachyura* than this would imply. DeHaan mentions and figures such forms in several species of Portunids, and the writer has noticed them in *Neptunus*, *Acheloüs*, *Epilobocera*, and *Pinnotheres*. In all these cases the abdominal appendages are more or less rudimentary and not well adapted for the attachment of eggs.

Thirty-two species of *Cambarus* and six of *Astacus* are described, and eleven species, all *Cambari* are new. The description of the species is followed by an extended account of their geographical distribution. The author remarks on the absence of crawfish in central and eastern New England and the eastern portion of British America, and does not seem to have been aware of their occurrence in the St. Johns and Aroostook rivers.*

The eleven plates contain figures of the first abdominal legs of the male and some other parts of nearly all the species, from the author's drawings, and beautifully executed figures of the entire animals of eight species. S. I. S.

5. *Preliminary Report on the Crustacea dredged in the Gulf Stream in the Straits of Florida;* by L. F. de Pourtales, Assist. U. S. Coast Survey. Part I, *Brachyura;* prepared by Dr. William Stimpson. Bulletin of the Museum of Comp. Zool., vol. ii, No. 2. 52 pp. Cambridge, Dec., 1870.—In this important paper, Dr. Stimpson gives a full list of the Brachyura collected by the Coast Survey dredging expeditions of 1867–8–9. 81 species, representing 47 genera, are mentioned, and 52 of the species and 19 of the genera are described as new. More than half the species belong to the Maioidea, while the Oxypodoidea are represented by only two species, both of them belonging to the Carcinoplacidæ. Only a small proportion of the species are from great depths, and the number of new forms seems largely due to the thorough exploration of the shallower waters. But 15 species are recorded as coming from below 100 fathoms, and of these 11 are Maioids, and the other 4 are Cancroids—a *Pilumnus*, 2 species of *Bathynectes* (a new genus allied to *Portunus*) and a species of *Acheloüs*. The

* Reports on the Natural History and Geology of Maine. In the Museum of Yale College, there are specimens of *Cambarus propinquus* from Montreal and from Madison, Wisc.

greatest depth at which any of the species were found is 150 fathoms; and it is quite remarkable that the only species from that depth were *Portunidæ*—one of the species of *Bathynectes* and the *Acheloüs*. S. I. S.

6. *On the Mineral Constituents of Meteorites;* by N. S. MASKELYNE, M.A., Prof. Min. Oxford, and Brit. Mus. (Trans. Roy. Soc., 1870).—Mr. Maskelyne takes up in this paper the analysis of the Busti aërolite of 1852. He finds in it the compound, mono-sulphide of calcium, in small spherules of pale chestnut-brown color, and transparent when pure, to which he gave the name *Oldhamite* in 1862; and minute golden-yellow octahedrons (isometric) named *Osbornite*. The amount of the latter obtained for analysis was too small for completed results; but led to the conclusion that it contains sulphur, calcium and some titanium-like metal, not titanium or zirconium, with a trace of iron. It is infusible, and not acted on by boiling nitric acid, and, heated in a current of dry oxygen, it undergoes only an external oxidation. Mr. Maskelyne calls attention to observations of Prof. Mallett on a gold-yellow incrustation obtained by heating zirconium with lime and aluminum, contained in this Journal, II, xxviii, 346.

The other constitutents of the aërolite were a magnesian enstatite the main part, augite, schreibersite, nickeliferous iron, and a very small proportion of troilite (FeS) and chromite. The augite is a magnesia-lime augite.

The Manegaum meteorite, which fell in 1843, was found by Mr. Maskelyne to consist *of a single silicate, and that enstatite;* the enstatite is a highly ferriferous variety, containing

$$\text{Si } 53{\cdot}63,\ \text{Fe } 20{\cdot}48,\ \text{Mg } 23{\cdot}32,\ \text{Ca } 1{\cdot}49,\ \text{Fe Cr } 1{\cdot}03 = 99{\cdot}95.$$

This meteorite contains only a minute amount of meteoric iron.

The investigations show that the flocculent opaque white mineral seen in the microscopic sections of many meteorites is often, if not always, enstatite.

7. *Fossil Mammals of the Rocky Mountains collected by Dr. Hayden;* Dr. LEIDY, (Proc. Acad. Nat. Sci. of Philadelphia, Oct. 4–18).—Dr. Leidy here brings out many new facts with regard to the Tertiary Mammalian life of this Continent.

On the Sweet Water river, eighteen miles west of Devil's Gate, Wyoming Terr., the bones are mostly of a species of Merycochœrus, smaller than *M. proprius;* but with these there are remains of an equine animal, perhaps a *Hipparion*, and of *Canis vafer* and *Merycodus necatus*, species first described from the Niobrara.

From Fort Bridger there is a molar of apparently a small species of *Lophiodon;* part of a lower jaw of a pachyderm, which is named provisionally *Hyopsodus paulus;* an animal allied to *Chalicotherium* and *Titanotherium*, which Dr. Leidy named *Palæosyops paludosus*, (other specimens of which have been received from Henry's Fork of Green river, Wyoming; a species related to the Peccary, named *Microsus cuspidatus*; and one related to the Raccoon, named *Notharctus tenebrosus*.

8. *Fossil Mammals from Oregon;* J. LEIDY, (ib.).—The specimens were from Rev. Thos. Condon of Dalles City, Oregon. Dr.

Leidy observes that the greater number of specimens belong to a species of *Oreodon* larger than any before described, and as large as *Merycochœrus proprius*, with which species it may be identical. He names it *Oreodon superbus*. There are also a few fragments of jaws of *O. Culbertsoni*, *Agriochœrus antiquus*, *Leptomeryx Evansi*, *Anchitherium Bairdi*. The above are from "the Big-bottom of the John Day river." From Bridge Creek, a tributary of the John Day, there are remains of *Lophiodon occidentalis?*, an animal about the size of *Tapirus terrestris*, two species of Rhinoceros, one the *R. occidentalis?*, another *R. hesperius?*, *Elotherium superbum?*, a Peccary as large as *Dicotyles torquatus*, an *Anchitherium* larger than *A. Bairdi*, called *A. Cordoni*.

9. *Cretaceous and Tertiary Reptilia and Fishes.*—In the Proceedings of the American Philosophical Society, Prof. Cope describes 4 species of Saurocephalus from the Cretaceous of Kansas, 1 of Icthyodectes (n. gen. near Saurocephalus) same locality, and several new fishes, chiefly Cyprinidæ, from a freshwater Tertiary deposit in Idaho discovered by Capt. C. King. Dr. Leidy has observed among mammalian remains from the same beds, portions of *Mastodon mirificus* and *Equus excelsus*, species that occur in the Niobrara beds and which have been referred to the Pliocene. The Mollusks of the beds, according to Meek, are different specifically, and some generically, from all others hitherto described from the West. Prof. Cope, in view of the characters of the fishes, says that there is great probability of the beds being later than Miocene, and nothing to conflict with their being Pliocene.

10. *Geological Survey of Ohio.* Part I, Report of Progress in 1869, by J. S. Newberry, Chief Geologist. Part II, Report of Progress in the Second District, by E. B. Andrews, Assistant Geologist. Part III, Report on Geology of Montgomery County, by Edward Orton, Assistant Geologist. 164 pp. 8vo, with a colored geological map of the state, and sections. Columbus, 1870.—Much interest attaches to the Geological Survey of Ohio, because of the position of the state between New York and the states of the Mississippi basin. The work already done by Dr. Newberry and his able associates has thrown much light on the connection between the two regions, besides adding many new facts with regard to the coal and coal beds of the state. We propose to notice the results at some length in our next number.

11. *Gas Wells in Ohio.*—Dr. Newberry states in a paper in the American Chemist for December, that the two gas wells bored by Mr. P. Neff in the valley of the Kokosing have been flowing gas in apparently undiminished volume to the present time. Other wells have since been opened. Near Millwood where the rocks are much disturbed, two wells give out oil, one three and the other eight gallons per day; two or three miles below, near the mouth of the Kokosing, the augur, on reaching the depth of 600 feet, struck into vertical crevices and sunk several feet without resistance; and from two crevices a volume of carburetted hydrogen issued which was unparalleled in all the oil explorations made in the country; the wells give out salt water intermittently, throw-

ing it to a height of over one hundred feet. The gas of one of the wells, lighted at the end of a pipe two inches in the clear set in the well head, produced a jet of flame 20 feet long and as large as a hogshead. By fixing a stop-cock in the pipe the gas was made to accumulate until, measured by a steam gauge, the pressure amounted to 180 pounds to the square inch. The gas appears to be pure and the volume sufficient to light a large city.

12. *Linnæan Hypothesis of the Derivation of species.*—Ludwig von Hohenbühel-Heufler contributes an article to the *Botanische Zeitung* for Sept. 9, 1870, in which he claims for Linnæus the origination of *the* theory of the derivation of species,—founding the claim upon the paragraphs which Linnæus appended to the sixth edition of his *Genera Plantarum*, published in 1764, viz:

1. "Creator T. O. in primordio vestiit Vegetabile *Medullare* principiis constitutivis diversi *Corticalis*, unde tot difformia individua, quot *Ordines* Naturales, prognata.
2. *Classicas* has (1) plantas Omnipotens miscuit inter se, unde tot *Genera* ordinum, quot inde plantæ.
3. *Genericas* has (2) miscuit Natura, unde tot *species* congeneres, quot hodie existunt.
4. *Species* has (3) miscuit Casus, unde totidem, quot passim occurrunt, *Varietates.*
5. Suadent hæc (1–4) *Creatoris* leges a simplicibus ad composita. *Naturæ* leges generationis in hybridis. *Hominis* leges ex observatis a posteriori.

Whatever meaning be put upon these somewhat enigmatical propositions, they certainly show that Linnæus (as a naturalist of his turn of mind was not unlikely to do) had thought of a derivative origin of species as not improbable, and had formed some idea of an hypothesis concerning it,—perhaps as definite as his idea of natural orders,—a problem he could suggest rather than solve. And it is interesting to note the scale of operating powers,—Chance sufficing for the production of varieties, Nature for genera, the Omnipotent directly for the mightier work of producing orders.

In a subsequent number of the *Bot. Zeitung*, that for November 18, the veteran senior editor, Von Mohl, takes up the subject, and maintains, with much reason, that the theory of Linnæus, whatever it amounts to, has no special likeness to the modern "Descendenztheorie," in any important particular. For, he concludes that the "a simplicibus ad composita" of Linnæus did not involve the idea of a rise in organization from a plant or plants of lowest to those of higher grade, nor did he imagine the diversification to have been a consequence of the inherent powers of the plants themselves, or to be still proceeding, so that the present is any representation of the past. But he thought it necessary to admit a direct interference of the Creator twice, once in the origination of plants representing the natural orders, and then in the supernatural diversification of these by *crossing*, to produce the genera; and only the genera are supposed to have mingled by crossing in virtue of the natural laws of propagation, so as to result

in the formation of the existing species, which species Mohl thinks, were regarded by Linnæus as unchangeable since their first appearance, excepting the mere accident of variation by hybridation, etc. So that Linnæus might with full consistency retain his well known definition or axiom: "Species tot sunt, quot diversas et constantes formas in hoc globo prodixit Infinitum Ens," etc., and so this axiom holds its place in the Ratio Operis of the same volume to which, at the close, this hypothesis of the diversification of species is appended. But we can hardly suppose that a philosopher like Linnæus would attribute this diversification as to species to natural causes, and then imagine that existent natural causes had ceased to operate; and he would certainly have seen that the continued crossing of the species of a genus would soon have resulted in the total obscuration of species. If he thought at all of harmonizing his practical definition with his suggested hypothesis, he probably regarded species as having only a relative stability, so as to be essentially unchanged for any period within human ken, whatever their origin or progress in the long run.

To throw some light upon Linnæus's enunciation, which appears so obscure, of an essential *medullary substance*, invested with an accessory *cortical substance* in all plants, Von Mohl makes a long extract from the dissertation of Linnæus upon Generatio Ambigena, published in the 6th vol. of the Amœnitates Academicæ,—a curious speculation which would take some time to explain, one to which Linnæus elsewhere refers, especially in explaining the nature of the blossom, and in which doubtless, as Mohl supposes, is to be found the key to the understanding of his derivative hypothesis. A. G.

13. *Monograph of the Ranunculaceæ of the Dominion of Canada;* by Prof. Geo. Lawson, Dalhousie College, Halifax, contributed to the Canadian Naturalist.—A full account of this family, with ample details as to geographical distribution, etc. In the character of the tribes the position of the seed is omitted, probably as too difficult for popular apprehension, though it is really easy enough. *Pulsatilla* is kept as a genus, but not *Atvagene*, yet the two would seem to stand or fall together, and *Hepatica* is reduced to *Anemone*. Of the latter genus, the name *A. dichotoma* replaces *A. Pennsylvanica*, "because the latter suggests erroneous ideas of the plant's distribution." We can adduce a far better reason, viz: that it is of almost twenty years later date. In the admission of *Thalictrum clavatum* as a Canadian plant, Prof. Lawson shows that he has not followed up the history of this species, nor noted that in the Manual its northern limit is said to be S. Virginia. He should substitute the name *T. sparsiflorum*, and see, for authority, *Plantæ Wrightianæ*, ii, p. 8, and this Journal, xlii, p. 17, as well as 33, new series, in the account of Dr. Parry's collection. The first and last of these references will throw light also upon the notable peculiarity mentioned in the geographical distribution of *Delphinium exaltatum*, which species, if at all Canadian, is likely to inhabit only the most southern latitude.

A. G.

14. *Œrsted on characters furnished by the styles in Cupuliferæ and Juglandeæ, etc.*—In the Copenhagen *Videnskabelige Meddelelser* a few years ago Prof. Œrsted very fully worked out and displayed the high systematic importance of the form of the styles and stigmas in *Quercus* and the other *Cupuliferæ*. To the same publication, for the year 1869, he has contributed a brief article on the same subject in relation to the Californian Holly Oak (*Quercus agrifolia*), in Danish, of which at the close of the volume he has kindly given a French translation. He shows that this oak, with the port of *Q. Ilex*, has the styles and calyx as well as the ovules of the mainly Asiatic subgenus *Erythrobalanus*, in which he forms for it a separate section.

To the volume for 1870, Œrsted contributes an analogous note upon *Juglandeæ*, in which, by the way, he points out the fact that *Pterocarya* differs from *Juglans* and *Carya* in having foliaceous four-parted cotyledons which rise out of ground in germination; and he proceeds to show that his *Oreonumoa*, from Central America, which in the Prodromus had been made a section of the Asiatic genus *Engelhardtia*, is remarkably distinguished by its styles and less so by its embryo. Both papers conclude with remarks upon the geographical distribution of these genera, etc., as related to recent geological changes. Noting that *Juglans*, *Carya*, and *Engelhardtia* were all three well represented in Europe during the Miocene period, he infers that America was thence supplied with *Juglans* and *Carya* by way of the west, and with the representative of *Engelhardtia* by the east. We think that all the known facts conspire to show that both came by the east and north. In the structure of the styles of *Quercus agrifolia* Œrsted detects an oriental origin; and he speculates suggestively upon the Asiatic elements in the Californian flora (which we think are few) and upon what he calls its insular character, meaning by this, probably, only its marked distinction from the eastern N. American flora. And he appears to attribute this to the Sierra Nevada, which he terms the *maritime* Alps of California. But a different and more efficient way of separation may readily be suggested. A. G.

III. Miscellaneous Scientific Intelligence.

1. *Meteorological Observations on Mt. Washington.*—The meteorological observatory, as it may be called, on Mt. Washington, which Prof. C. Hitchcock, the head of the Geological Survey of New Hampshire, and Prof. J. H. Huntington have been the means of establishing, has for its observers Prof. Huntington, Mr. S. A. Nelson of Georgetown, Mass., and Sergeant Theodore Smith. The latter is also telegrapher, and was appointed to the station by General Myer, head of the "Bureau of Telegrams and Reports for the Benefit of Commerce," recently established by Congress. In addition, Messrs. A. F. Clough and H. A. Kimball are the photographers. Prof. C. H. Hitchcock, at Hanover, has telegraphic connection with the summit, and occasionally joins the observers.

Gen. Myer ordered the laying of the telegraphic wire to the summit, so that a daily statement of the observations might be sent to Washington and to the rest of the country. The house occupied by the observers is the depot of the Mt. Washington railroad. The party has two barometers, thermometers, a hydrometer, Robinson's self-registering anemometer, and an anemoscope. Three daily telegraphic reports are sent out, two to the Bureau of Telegrams at Washington, and one to the New England Associated Press, Boston. The party give their time and labor without remuneration. The expenses, apart from those of the agent of the Bureau of Telegrams, have been assumed by Prof. Hitchcock, he depending on the public for its return. He states in a letter dated December 31st, that two hundred dollars more are needed to carry them through the season. Part of the expenses come from the necessity of keeping a watch for the telegraph wire in the windy region between Littlefield and the mountains.

2. *Unusual exhibition of halos.*—On the morning of Dec. 21, 1870, there was observed at Galesburg, Illinois, an unusual exhibition of halos. The phenomenon began when the sun rose, and continued till nearly noon, though after ten o'clock nothing was seen but the common halo of 22° radius. About 45 minutes after sunrise, there was seen the halo of 22° radius; that of 46° radius; a parhelic circle through the sun, parallel to the horizon; two parhelia on each side of the sun near the intersection of the parhelic circle with the two halos; a contact arch near the highest point of each of the halos; and a vertical column passing through the sun. All these phenomena are represented by figures in Loomis's Treatise on Meteorology, pages 216–219. Besides these appearances there were also noticed lines of illumination nearly vertical, but somewhat concave toward the sun, about five or six degrees in length, touching the circle of 46° radius at the points where it was intersected by the parhelic circle. These arcs are of unusual occurrence. They are, however, noticed by Prof. Bravais in his Memoir on Halos in the Journal de l'Ecole Polytechnique, t. 18, p. 112.

The temperature at the time of these halos was about zero, and the air was full of frost, driven sometimes in light clouds before a brisk N.W. breeze. For the above information we are indebted to a letter from Prof. M. L. Comstock of Knox College.

3. *Head Waters of the Amazon.— Observations on the Geography and Archæology of Peru;* by E. G. Squier. 28 pp. 8vo. (Read before the Amer. Geogr. Soc., Feb., 1870).—In the course of this interesting Memoir, Mr. Squier discusses the question whether the river Marañon or the Ucayali, (the two rivers which unite to form the Amazon), should be considered the main head of the Amazon. He observes that the Ucayali exceeds the Marañon by several hundreds of miles, whether its longest branch be the Urubamba or Vilcamayo rising at the lake of La Raza, or the Apurimac rising in the department of Arequipa. As regards volume, he cites Dr. Tavara, a member of the Hydrographic Commission of 1868, under the Peruvian government, who says

that the Marañon both in length and volume is inferior to the Ucayali, and it therefore "leaves the latter to bear without dispute the title of Rio Madre del Amazonas." The Ucayali is navigable from the junction of the two rivers, the Urubamba (or Vilcamayo) and the Tambo which join to form it, down to the Amazon, a distance of 772 miles; and the Urubamba is navigable for small vessels for 216 miles, or 220 miles from Cuzco, the capital of the most populous department of Peru, and that with which communication with the Amazon would be of the highest importance.

4. *Solar Eclipse.*—No information has yet been received (Jan. 16th) with regard to the observations on the recent solar eclipse beyond the general intelligence that the observers had good weather in Spain, and only moderately good in Sicily; and the fact that the Psyche, having the Sicilian party from England on board, foundered on a sunken rock off Catania, but without loss of hands or of scientific instruments.

5. *Murchison* was disabled near the close of November by a stroke of paralysis. According to the latest reports he will soon be at work again.

6. *Prof. Balfour Stewart* was among the sufferers by the collision on the London and Northwestern Railway, on the 26th of November. He is reported as gaining as rapidly as could be expected, considering the nature of his injuries.

OBITUARY.

G. Bischof, the author of the great work on Chemical Geology and of various researches on related subjects, died early in December last, at Bonn.

Wm. Chauvenet, author of several mathematical works of high merit, and for some years Chancellor of the University of St. Louis, died at St. Paul, Minn., Dec. 13, 1870, aged 51.

IV. Miscellaneous Bibliography.

1. *The Journal of the Franklin Institute.* Editors, Drs. Morton and Wahl. Philadelphia, Pa.—Our esteemed contemporary enters with its current number upon its 46th year; and we are pleased to learn, with every prospect for prosperity and continued usefulness.

Devoted strictly to Mechanical and Physical Science, it has long and ably held an honored position among American journals and is the favorite organ of our practical scientists.

As the written tradition of the oldest Mechanics' Institute in America, it is well entitled, by this time, to wear grey hairs,—yet no such grave characteristics are visible to us; and if it is literally to "renew its youth" for another half century, the hands in which we now find it are well qualified to inaugurate the happy era.

2. *The Malay Archipelago: the Land of the Orang-utan and the Bird of Paradise. A Narrative of Travel, with Studies of Man and Nature;* by Alfred Russell Wallace, author of "Travels on the Amazon and Rio Negro." "Palm Trees of the Amazon," etc. 638 pp. 12mo. New York, 1869. (Haperr &

Bros.)—Although it is over a year since this work was published, it deserves mention here. Mr. Wallace's explorations were undertaken for the purpose of collecting specimens in Natural History. His work gives much interesting information on the customs of the people he visited, but is chiefly important to science, on account of its notes on the habits, peculiarities and geographical distribution of the animal and vegetable life of the various islands. As the idea of "Natural selection" had already come to him, he aims to point out the bearings of the various facts on the question of variation, and thereby on the origin of species. All will not accept his conclusions, which seem sometimes forced, but they cannot fail to read with interest and profit the results of his observations, although given with an excess of personal detail. The volume contains a map of the East Indies, and many excellent illustrations.

3. *Adventures of a Young Naturalist;* by L. BIART, edited and adapted by Parker Gillmore, author of "All Round the World," etc. 492 pp. 12mo, with 117 illustrations. New York, 1871, (Harper & Brothers.)—Our School system will not be complete in its arrangement of studies until children are made to enter upon some simple course in Natural History—teaching them how and what to see in this objective world,—from the time they are ten or eleven years of age. It is well for them, that while the schools are thus defective, they are partly supplied with the means of such instruction in the "Young" literature of the day; and one of the best books for the purpose is the Adventures of a Young Naturalist. The region of these adventures was Mexico. Facts about its prominent trees, flowers, and animal life, and the physical phenomena that appear by the way are introduced as a part of the adventures, and usually in a manner that adds interest to the story. The volume is illustrated by a multitude of engravings, which exhibit, with wonderful exactness and artistic effect, the forest scenes of the tropics. We should like to change the page on aërolites and some other paragraphs. But in general the book is well suited to its purpose.

4. *The Rob Roy on the Jordan, Nile, Red Sea, etc.;* by J. MACGREGOR. 464 pp. 12mo, with maps and illustrations. New York, 1870. (Harper & Brothers).—This admirable book of canoe travel by a man of resource and culture, and of sympathy with all that is good and beautiful, is not without special scientific interest, as it contains excellent descriptions of natural scenery of rivers and mountains, treats of the present distribution of the crocodile of the Nile, and gives the first account published of the head-waters of the Jordan. [2, 3, 4 are originally English publications.]

United States Geological Exploration of the Fortieth Parallel: Clarence King, Geologist in charge. Vol III. Mining Industry by James D. Hague, with geological contributions by Clarence King. 648 pp. 4to, illustrated by 37 plates and an accompanying Atlas of 14 colored Imperial folio plates. Washington, (Government Printing Office.) 1870.

Report on the Geological Survey of the State of Iowa, made to the thirtieth General Assembly, Jan. 7, 1870, containing results of examinations and observations made within the years 1866–1869; by Charles A. White M.D. Vol. I. 392 pp. royal 8vo with maps, views, and sections. Des Moines, 1870. Geological Corps, C. A. WHITE, State Geologist, O. H. ST. JOHN, Assistant, R. EMERY, Chemist.

APPENDIX.

Letter to the Editors from Prof. B. A. GOULD, *dated Cordoba (Cordova), November* 9, 1870.

I WILL begin to-day to fulfil my promise of writing to you from time to time of the progress of our Argentine Observatory, or rather of the preparations for its organization.

Leaving New York on the 28th of May, and arriving in England after 11 days, just six weeks were available for a hurried visit to London, Paris, and some of the German cities, where instruments were constructing, or books were to be obtained. Fortunately all was then peaceful and happy, and the sudden outburst of war did not take place until we were in England again, and on the point of re-embarkation. The greatest interest and sympathy were manifested by all the astronomers whom I met; and many of them gave expression to their good-will in a very practical and tangible manner, by gifts of serviceable books and by essential assistance.

On July 20, we left Liverpool in a steamship bearing the auspicious name of "Tycho Brahe," and landed on August 23d in Buenos Aires, where the cordiality of our reception could scarcely be surpassed. The officers of the National Government have afforded every courtesy and assistance possible, while the citizens seem to feel a sincere and most intelligent interest in our undertaking, and have extended to us a most friendly and gratifying welcome. Only two or three days previous to my arrival, an appropriation had been passed by the National Congress for the acquisition of additional instruments and books; but on a subsequent reconsideration a further amount was added for the purpose of completing and extending the building, which had been but partially provided for.

While crossing the tropics, I was much impressed by the luminosity of the background of the heavens, by night. This afforded a light not inferior to that of the sky when the moon is at her quarter,—reducing the apparent brilliancy of the stars, and often rendering it difficult to recognize the outline of prominent constellations. I have an indistinct remembrance of reading some similar remark, in Humboldt's personal narrative, I think; but of course I have here no means of refreshing my memory. This brightness was not dissimilar to that of the interior of an auroral arch. Can it be that this phenomenon stands in some relation to zodiacal light? That this latter is a terrestrial appendage and not a solar one, I have long regarded as demonstrated. This atmospheric or superatmospheric brightness first attracted my attention when we had reached the latitude of 30° N., and was much fainter soon after we had crossed the equator. The lenticular outline of the zodiacal light was not visible in the west after sunset on these occasions; indeed, the general brightness of the sky was quite as great as I have ever seen that of the zodiacal light itself.

My own family reached Cordoba on the night of September 8, and I lost no time in selecting a site for the Observatory. The

Provincial Government undertook to purchase and present to the Observatory a piece of land 250 varas (216·9^{m}) square, and within four days the position was chosen and the preliminary steps were taken for the acquisition of the ground. At present the foundations, both for the buildings and the piers of the instruments, are essentially completed, and there is no doubt in my own mind that the mason work for the whole building will be completed at the close of November.

Cordoba is situated only about ten miles east of the base of the Sierra, and occupies an eroded basin, about 1¼ miles in width, along the north side of which runs the Rio Primero, which, rising in the Sierra, discharges its waters into a salt lake some eighty miles farther eastward. It is so easily fordable, except in the rainy season, that no bridge has been constructed across it until this present month, but an iron one has now been erected by the National Government. The valley of the river, which is here expanded into a basin, although much contracted both above and below the town, is bounded by walls of sandy clay, or rather by what would be walls were it not for their very broken and irregular outline, caused by the wash of the torrents, which pour down into the hollow after every rain, leaving ravines or gullies of from ten to forty feet deep, which extend far into the plain above,—forming a miniature coast indented by fiords, like the shores of Norway and Scotland. The city itself rests on a bed of firm granitic sand, which drifts with the wind; but the dustiness of the unwatered plains of fine powdered clay on the pampa above cannot be described. The *barranca*, or bank, varies in height from eight to twenty-six meters, and the land then rises with a gentle slope southward to the divide between the rivers Primero and Segundo, and northward similarly for a considerable distance. At a distance of two miles from the city, north or south, only the summits of the many church-towers are visible, springing apparently out of the ground. The elevation of the town above the sea-level is variously stated, but cannot be far from four hundred meters; the whole pampa having a slight inclination from the mountains to the sea.

Of course it was out of the question to place the Observatory in the hollow, for want of a proper horizon, as well as on account of the numerous obstructions from houses or trees. Upon the barranca, a better foundation is likewise afforded upon the *tosca*, or hard clay, which alternates with sand in successive strata. The disadvantages consist in the distance from other dwellings, and in the total want of water, which can only be obtained from the river, or from wells of some seventy meters or more in depth; —while the impalpable and all pervading dust will inevitably render the instruments valueless, unless an abundant vegetation be maintained in the immediate vicinity of the building. For this, means will doubtless be provided in some way, inasmuch as the Minister, and all the officers of Government who have to do with the affairs of the Observatory, are evidently anxious to do every thing in their power to promote its success.

The four assistants arrived Sept. 26, and on Oct. 17, came the first instalments of material for the building. The plans had been excellently worked out by Messrs. Harris and Ryder of Boston, who had also superintended the construction of those portions which consist of iron,—such as the roof, floors, stairways, revolving dome, and machinery for opening and closing the shutters,—all in a manner which reflects on them the highest credit. But to my deep regret and mortification, the carpentry had been shipped in such an improper manner, and the bills of lading so loosely made out, that the materials have arrived in an unsatisfactory state; much being missing and more badly broken, while we have no legal hold on the ship. When the parts are assorted for putting together, which will probably be in a month, I hope the state of affairs will prove better than present indications promise.

The small portable transit instrument of the Coast Survey has been in use for the past week under a little hut of bricks and mud constructed for the purpose, and the Smithsonian zenith-telescope is just put in place. From such means of judgment as I have yet obtained, I suppose the geographical position to be not far from 31° 24′ 40″ south latitude and $0^h\ 52^m\ 34''$ east from Washington.

The meteorological relations of this region are evidently very peculiar, and I deeply regret my want of apparatus for their proper investigation without trenching upon the means and energies requisite for our legitimate astronomical work. In Buenos Aires the winter is a rainy season, while the summers are dry. Here, at a distance of 500 miles, the reverse holds good; the winters being absolutely rainless, but the summers subject to frequent and very violent rains. A sharp shower of half an hour on Sept. 29th, was the first rain of the season, none having fallen up to that time since the beginning of May. Now we have a shower every three or four days, always violent and copious, but not generally continuing for more than an hour. Later in the summer we are told that they will be yet more impetuous and of longer duration; but a continued storm of half a day or more is said to be unknown here. Thunder and lighting are the unfailing attendants of these rains, and I have never seen more splendid exhibitions of atmospheric electricity than have accompanied every one of the eight or ten which have occurred during the past month. The volume of water which falls on these occasions is immense. The river often rises many feet in a single hour, receding afterward nearly as rapidly. Part of the town is traversed by what is called the cañada, the bed of a water-course some 6 or 7 meters in breadth, which discharges into the river, and is bordered by steep banks until it reaches the basin in which the town is situated. This is usually dry, in fact I have never seen it otherwise, although I am residing within 50 yards of it, and cross it many times a day. But during, and immediately after, one of these violent rains, it becomes the channel of a torrent, and has been known to rise to the height of 4 meters in two hours. It is fed by no spring, and merely brings down the surface drainage of a few miles of pampa; yet but for a strong dike built by the Jesuits in 1671, the city

would be subject to severe inundations. Indeed a flood from this cañada did destroy a large part of the town in 1623. The whole line of the barranca is intersected by ravines similar in character to this cañada, and it is these which produce the broken jagged outline of which I have spoken. I have found it impossible to select a fitting place for the observatory, where the grounds could be unbroken by these gullies, and care will be needful to prevent the descent to a lower level of much of the soil which has been given us.

The wind is very rarely from the east, and I am informed that it has never been known to be due west; a circumstance doubtless attributable in great part to the barrier presented by the magnificent Sierra west of the city. The winters are very chilly, even snow being not infrequent, although ice does not form. Even now while roses, cactuses, cassias and white lilies are in full bloom, the young peaches of half their full size, and the grapes well formed, —the mornings are uncomfortably chilly, and no one thinks of wearing other clothes than woolen. Yet before the sun is an hour high, and until he has gone down in the west, his beams are simply intolerable. The foreigner who goes about or exercises in the sunshine between 12 and 2, is sure to rue it, and the natives never commit such an indiscretion. The astronomer, whose exposure is by night, finds himself for once at a vantage in the fiery Argentine summer. Yet the air is not so hot as the torrid climate would suggest; and the nights even in midsummer are cool.

The dryness of the air has impressed me quite as much as any other climatic peculiarity. A bowl of water left uncovered in the morning is dry at night; ink vanishes from the inkstand and becomes thick almost by magic; the bodies of animals, left exposed, dry up instead of decomposing; and at other times than during, or immediately after a rain, neither active exercise nor exposure to the sun's rays cause a perceptible perspiration.

We are suffering no small embarrassment from the non-arrival of our books and instruments from Germany. The Meridian circle, clocks, chronometer, photometer, etc., were all on board ship at Hamburg, when the war was declared, and up to the last advices, although the blockade of the Elbe had been raised, no vessel for the River La Plata had ventured to leave port. Should another month pass without their arrival it would be a serious drawback to us. Meantime there is plenty of work to be done in superintending the building, and making the numerous preliminary calculations for places of standard stars, tables of reduction, etc. Should the meridian-circle be long delayed, the time might be well employed in making such a Uranometry for the southern sky as the absence of a photometer will allow,—on the same plan as Argelander's, and as my unpublished northern one, made at Albany in 1858.

The temporary embarrassments of the Government-treasury, occasioned by the serious and destructive insurrection in Entre Rios, may slightly retard our progress, or at least render it less easy for the necessary means to be provided, especially since the carpentry has arrived in so unfortunate a condition; but that cordial desire to facilitate our work, which clearly animates all parties here, will doubtless reduce difficulties of this sort to a minimum while they continue, and render their duration as brief as may be.

POSTSCRIPT.—*Solar Eclipse of December 22nd.*

Through the kindness of Prof. J. E. HILGARD, Assistant in Charge, U. S. Coast Survey, Washington, we are enabled to publish the following extracts from two letters, giving information respecting the observations on the Eclipse made in Sicily. Other extracts follow from letters published in the New York daily papers.

From letter of General E. ABBOT *to Prof. J. E. Hilgard, dated at sea, Jan.* 17, 1871.—From our party in Spain I have heard nothing. In Sicily we had hard luck, but got some good observations, notwithstanding. The expedition was divided into five parties. At *Catania* were the photographers, with Mr. Schott and Prof. Lane. Clouds prevented observations of the corona. At a villa in the environs of the town, were Prof. P. and his two sons and Mrs. P.; they had good luck, the clouds opening just so that they could observe the corona. They got good sketches and good polariscope observations. At *Monte Rossi* (3000 feet altitude) Prof. Peters failed from clouds. At *Carlentini* (on contact line south of Catania), Prof. Watson got very valuable observations on the corona. On Etna (8400 feet altitude) Gen. Abbot failed from clouds. So two-fifths of our party succeeded, and in combination with similar partial observations of the English, &c. parties, we have settled that the corona is, in part at least, solar. The light is strongly polarized in radial planes. The spectroscope failed except a partial observation by the English, which goes to confirm last year's observations in America.

From a letter from Prof. PEIRCE, *dated at Catania, Dec.* 22, 1870, *and published in the Boston Advertiser.—Half-past four.*—Well, the eclipse is over, and, wonderful to relate, all the success seems to have been reserved for our party. Mr. —— has got admirable results with his polariscope; —— and —— have made valuable sketches of the corona, and all the large party assembled at the villa were delighted with the whole phenomenon, to which the epithet of *magnifique* was applied on all sides. And you would like to know how it was that there was so great success with us, and not with the others. Well, it was thus: early in the morning all was bright and fair, but as the day advanced clouds began to appear, which increased greatly with the cold, arising from the diminished action of the sun upon the earth. These clouds kept growing with a rising wind till nearly at the middle of the eclipse, the sun was hidden behind a thick, black screen, and all hopes of further view of it deserted us. But just previously to the instant of total obscuration there was a break in the clouds, which was the more remarkable because it was raining and hailing at the time. This break did not extend a thousand feet from the place where we observed. But it gave us a superb view of the corona and the whole totality, and enabled us to establish very important conclusions. It must be said, however, that there was just enough haze to deprive us of what I am disposed to call the false corona, and which I consider to be a part of our own atmosphere. But the true solar corona is clearly proved to be a solar atmosphere extending about eight [eighty?] thousand miles above the ordinarily visible surface of the sun. There were three different sources of proof of this conclusion. The work is done successfully.

Observations by Prof. HARKNESS *and others*, (N. Y. Times, Jan. 24.)—Prof. Harkness, who was in Sicily, and Mr. Burton, at Agosta,

state that in their spectroscopic observations, the ordinary spectrum of the chromosphere and hydrogen flames was seen, and outside of the part of the spectrum due to the chromosphere, there was a *clear green line.* As to the nature of the green line they have only the fact that the lines were not those of hydrogen, or of iron, or of any known terrestrial substance.

It is further stated that the corona, according to an observer (name not mentioned), is strongly polarized, and hence shines by reflected light; and it is polarized in such a way as to prove that it is not atmospheric; and hence, it is added, it may be considered as a solar appendage reflecting in an eclipse the light of the obscured sun. Prof. Watson asserts that he has seen a part of the corona float away "like a vail," which suggests that its matter is constantly dispersing.

Observations of Prof. C. A. Young, Jerez, Spain, (Tribune, Jan. 25th).—The sun was obscured until totality, and just then a small rift in the heavy clouds opened the sun to view, and gave an opportunity for excellent observations. One good photograph of the corona was obtained. Prof. Young writes as follows:

Our spectroscopic results completely confirm those of last year, except that the two faint lines, which I saw between D and E last year and suspected to be corona lines as well as 1474, were not seen at all this time; 1474 was traced by Prof. Winlock to a distance of nearly 20′ from the sun's limb. I traced it 16′ on the West, 12′ on the North, 14′ on the East, and about 10′ on the South. The principal chromosphere lines were also visible in the corona to a distance of 3′ or 4′. Prof. Winlock and myself both agree in attributing this to the reflection of the haze around the sun. I am more confident as to this, because last year, in a clear atmosphere, the C line was certainly sharply terminated at the upper limit of the chromosphere or prominences under observation.

But the most interesting spectroscopic observation of the eclipse appears to me to be the ascertaining at the base of the chromosphere, and, of course, in immediate contact with the photosphere, of a thin layer in whose spectrum the dark lines of the ordinary solar spectrum are all reversed. Just previous to totality, I had carefully adjusted the slit tangential to the sun's limb at the point where the second contact would take place, and was watching the gradual brightening of 1474 and the magnesium lines. As the crescent grew narrower, I noticed a fading out, so to speak, of all the dark lines in the field of view, but was not at all prepared for the beautiful phenomenon which presented itself when the moon finally covered the whole photosphere. Then the whole field was at once filled with brilliant lines, which suddenly flashed into brightness and then gradually faded away until, in less than two seconds, nothing remained but the lines I had been watching. The slit was very close, and the definition perfect.

Of course I cannot positively assert that all the bright lines held exactly the same position that had been occupied by dark ones previously, but I feel very sure of it, as I particularly noticed several groups, and the whole arrangement and relative intensity struck me as perfectly familiar.

This observation is a confirmation of Secchi's continuous spectrum at the edge of the sun, and I think tends to make tenable the original theory of Kirchoff as to the constitution of the sun and the origin of the dark lines in the ordinary solar spectrum.